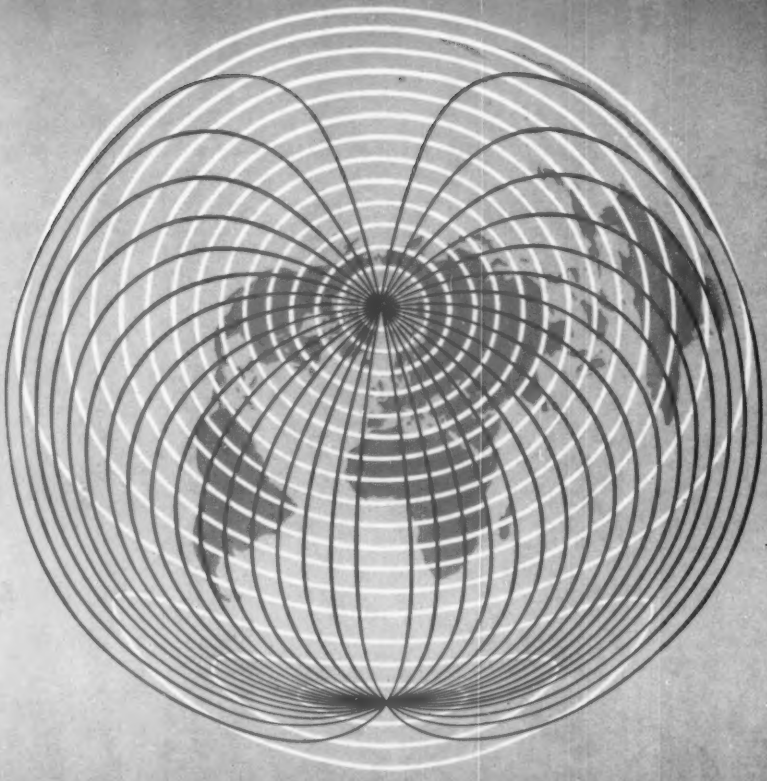
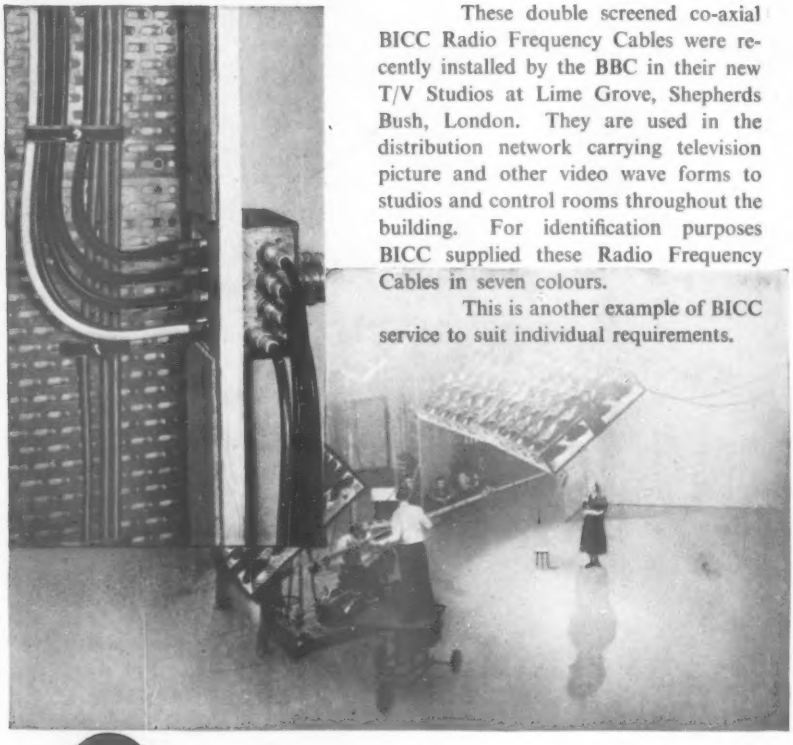
Wireless World

OCTOBER 1951 · TWO SHILLINGS



RADIO, TELEVISION AND ELECTRONICS

B.B.C. INSTALL BICC R.F. CABLES IN LIME GROVE T/V STUDIOS

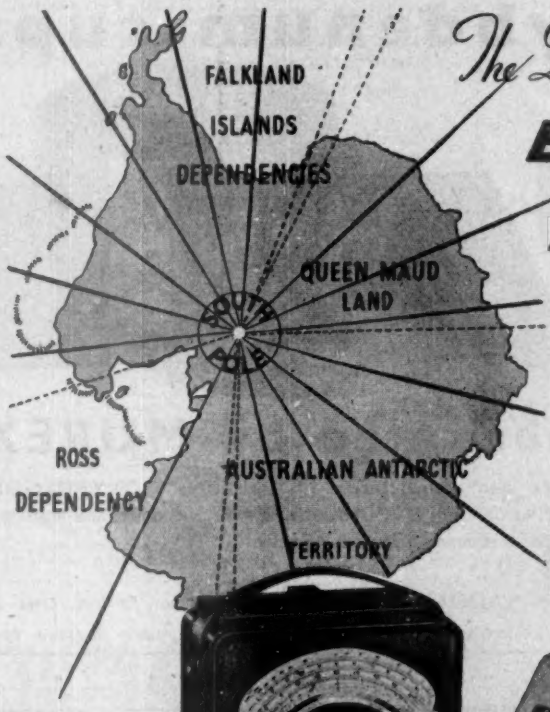


These double screened co-axial BICC Radio Frequency Cables were recently installed by the BBC in their new T/V Studios at Lime Grove, Shepherds Bush, London. They are used in the distribution network carrying television picture and other video wave forms to studios and control rooms throughout the building. For identification purposes BICC supplied these Radio Frequency Cables in seven colours.

This is another example of BICC service to suit individual requirements.

B.I. Callender's **RADIO FREQUENCY CABLES**

BRITISH INSULATED CALLENDER'S CABLES LIMITED
NORFOLK HOUSE, NORFOLK STREET, LONDON, W.C.2



The Queen Maud Land EXPEDITION

Relies on 'AVO' INSTRUMENTS

First of its kind in Polar history, the Norwegian-British-Swedish Antarctic expedition is spending 2½ years far beyond the ice-girdled coasts of a region where man has not hitherto set foot. A primary aim of the explorers, who are fully equipped for scientific research, will be a complete meteorological survey which may show why the world is growing warmer.

Radar is included in the modern surveying apparatus, and at the request of Mr. G. de Q. Robin, the British party's Australian Radar expert, we have provided an "Avo" Electronic TestMeter and two Model 7 Universal AvoMeters. We are honoured that "Avo" instruments have been chosen for such important work under conditions so exceptionally exacting.

MODEL 7 UNIVERSAL AVOMETER

The world's most widely used combination electrical measuring instrument; it provides 50 ranges of readings (current, voltage, resistance, capacity, power output and decibels) on a 5-inch hand-calibrated scale. An automatic overload cutout safeguards it against misuse. It is compact, portable and self-contained and the small power consumption (the total resistance of the instrument is 500,000 ohms) makes this meter particularly suitable for all radio and electrical testing.

Size: 8in. × 7½in. × 4½in.
Weight 6½ lbs.

£19 : 10s.

The AVO ELECTRONIC TESTMETER

Robust and portable, this is a 56-range instrument combining the sensitivity of a delicate galvanometer with the sturdiness of an ordinary multi-range meter. Basically a highly stable D.C. Valve Millivoltmeter, it can be quickly set up for any test requiring accuracy and negligible loading on the circuit. A well designed H.F. probe enables readings to be made at frequencies up to 200 Mc/s. Operates on 100-130 V. and 200-260 V., 50-60 c/s A.C.

Size: 12½in. × 9in. × 5½in.
Weight: 12½ lbs.

£40

PRECISION ELECTRICAL TESTING INSTRUMENTS

Fully descriptive pamphlets on application to the Sole Proprietors and Manufacturers:

THE AUTOMATIC COIL WINDER & ELECTRICAL EQUIPMENT CO. LTD.
WINDER HOUSE • DOUGLAS STREET • LONDON • S.W.1 *Telephone: VICTORIA 3404/9*

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Murex also manufacture: TUNGSTEN, MOLYBDENUM, TANTALUM and ZIRCONIUM rod, wire and sheet, and fabricated components made from these metals.

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YOU CAN MAGNETICALLY RECORD
using your Gramophone Motor as a Drive

Necessary parts, also usable later for a more ambitious job, plans available, 1 Spool Diamond Magnetic Recording Tape and 1 take-up spool, 2 Corner Brackets, 1 Roller, 1 Record-playback Head Kit, 1 Friction Clutch, 1 Dual-purpose Supersonic Oscillator and Two-stage Preamplifier and your Radio Chassis. Set of parts £7.15.0 or items supplied separately.

Also Constructional Data for Wire and Tape Recorders 5s.

PARK RADIO OF MANOR PARK, 676/8, 783 Romford Road, London, E.12

DATA ON THE MT57 TRIODE MERCURY VAPOUR RECTIFIER, ONE OF THE RANGE OF MULLARD THYRATRONS

LIMITING VALUES (ABSOLUTE RATINGS)

Maximum Peak Anode Voltage	
Inverse	1000V *
Forward	1000V
Maximum Cathode Current. 25c/s and above.	
Peak (for general control service)	18A
Peak (for ignitor firing service)	40A
Average (for general control service)	2.5A
Average (for ignitor firing service)	1.0A
Maximum averaging time	15 secs.
Surge (maximum duration 0.1 secs.)	200A
Maximum Grid Voltage.	
Before conduction	−500V
During conduction	−10V
Maximum Grid Current.	
Average (Averaging time 15 secs.)	0.25A
Maximum Grid Resistor	0.1MΩ
Min. Cathode preheating time.	300 secs.
Condensed Mercury Temperature Limits.	40 to 80°C

CHARACTERISTICS.

Heater Voltage			5.0V
Heater Current			4.5A
Capacitance Anode-grid			4μμF
Deionisation Time (approx.)			1000μ secs.
Ionisation Time (approx.)			10μ secs.
Anode Voltage Drop			16V
Control			
Anode Voltage	50	100	1000V
Critical grid Voltage (approx.)	0	−1.75	−6.5V

Base 4-pin UX.

* 1800V for condensed Mercury temperature up to 75°C

THYRATRONS

for fixed and ...obile applications

The Mullard range of Thyratrons has now been extended to include types suitable for use in both fixed and mobile equipments.

For fixed power and motor speed control applications, a selection of Mercury Vapour tubes is available providing maximum average anode current ratings from 0.5 to 6.4 amperes.

For relay, switching and motor control applications in aircraft, ships and industry where movement is encountered, a selection of rare-gas-filled tubes is also available. Important among these is a series of xenon-filled tubes with anode current ratings from 0.1 to 6.4 amperes. On account of the small variations-with-temperature of xenon gas, these tubes are ideal for use in equipments operating over a large ambient temperature range.

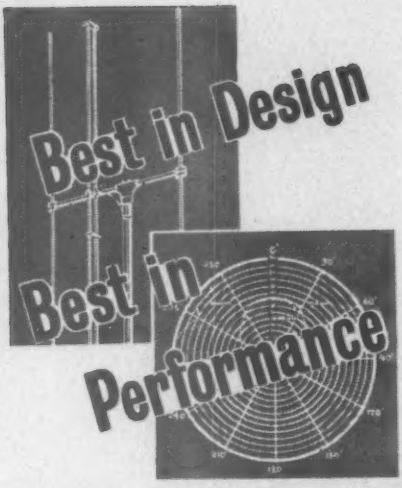
The Thyratron illustrated and described here is the 2.5 amp. MT57. Full details on the complete range of Mullard Thyratrons will be supplied on request.

Mullard

INDUSTRIAL POWER VALVES · THYRATRONS · INDUSTRIAL RECTIFIERS · PHOTOCELLS FLASH TUBES · ACCELEROMETERS · CATHODE RAY TUBES · STABILISERS AND REFERENCE LEVEL TUBES · COLD CATHODE TUBES · ELECTROMETERS, ETC.

MULLARD LTD., CENTURY HOUSE, SHAFTESBURY AVENUE, LONDON, W.C.2

MVT 96



CLEAR PICTURES
in "poor reception" areas

The models 63 and 63A have been designed for maximum performance in fringe and difficult reception areas. Since the reception of your TV receiver is wholly dependent on the efficiency of the aerial system, the Aerialite features of greater gain, broader bandwidth and sharper directivity are very worthwhile. There is every reason why you should specify Aerialite for your TV aerial if you wish to ensure strong, clear and interference-free pictures. The models 63 and 63A are priced at £11.15.0 and £12.5.0 respectively, complete with 10ft. masts, lashings, etc. Models with 14ft. masts are available at 17/- extra. Aerialite are manufacturers of a comprehensive range of TV and radio aerials as well as coaxial and R.F. cables.

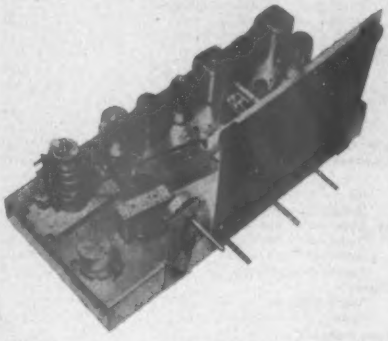
Aerialite LTD.

CASTLE WORKS STALYBRIDGE CHESHIRE

Two *major* Additions

to our range of receiver chassis suitable for radio-gram installations

ACE U331



5-valve, 3 waveband, A.C./D.C. mains superhet receiver with matched 10" speaker

MAJOR A331

5-valve, 3 waveband, A.C. mains receiver with matched 10" speaker

MAJOR DISTRIBUTORS

7 CAVENDISH PLACE, LONDON, W.1

Telephone: WILlesden 6713

Professional Quality

TAPE RECORDING and Playback EQUIPMENT

Behind the model PMR/1 is more than twenty years' experience in the design and production of high quality sound recording equipment for the professional user.

This up-to-the-minute tape recorder is essentially simple to handle, load and unload with tape. The complete mechanism for record, high-speed wind-back and wind-on, and playback is controlled by one knob only. Three separate motors are employed, one each for the capstan head, the magazine reel and the take-up reel. In this way, by eliminating belts or other transmission units, long-sustained consistent performance is assured, and maintenance problems are virtually non-existent.

The tape speed is 7½ in. per second, giving a continuous recording time of 30 minutes with a 1,200 ft. reel; but since two tracks can be recorded on the tape width, the total recording time per 1,200 ft. reel is one hour.

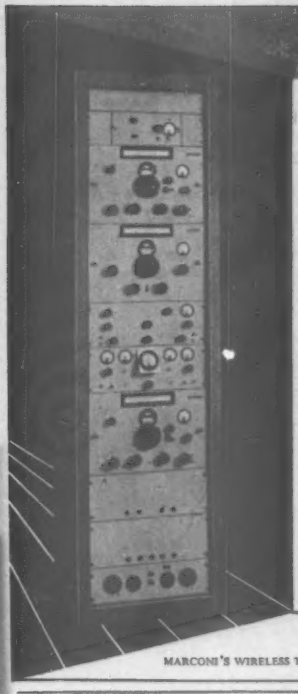
The amplifiers and equalisation have been designed to give the best possible frequency range and a really good signal/noise ratio. The frequency characteristic is flat, plus or minus 2 db., from 50 c/s to 9,000 c/s and not more than minus 6 db. at 10,000 c/s. The dynamic range is of the order of 50 db. A modulation meter enables the operator to modulate the tape fully without overloading. Two input jacks are provided, one for a high-quality microphone (20 ohms) and one for a line of 600 ohms impedance. Outputs are provided for a 15 ohms loudspeaker (7 watts) and also for feeding a M.S.S. cutter-head direct, so that dubbing from tape to disk may be carried out without additional amplifiers. A separate volume control for the monitoring loudspeaker is fitted.

THE MASTER SOUND SYSTEM

- SINGLE KNOB CONTROL
- THREE SEPARATE MOTORS
- 30 MINUTES CONTINUOUS RECORDING
- TWIN TRACK provides ONE HOUR'S RECORDING
- DIRECT DUBBING TO DISK WITHOUT ADDITIONAL AMPLIFIERS

M.S.S. RECORDING COMPANY LIMITED

FOYLE CLOSE · COLNBROOK · BUCKS TELEPHONE · COLNBROOK 284



DOUBLE DIVERSITY TELEPHONY RECEIVER

(CRD. 150/22A)

- Suitable for D.S.B. telephony.
- **Frequency range:** 1.5 - 30 Mc/s.
- **Receives:** Frequency Shift or On/Off telegraphy or telephony transmissions.
- **Outputs:** Telegraphy: Double current or keyed tone. Telephony: 100 mW into 600 ohms.
- **Supplies:** 100 or 200-250 volts, 50 c/s mains, 600 watts consumption.

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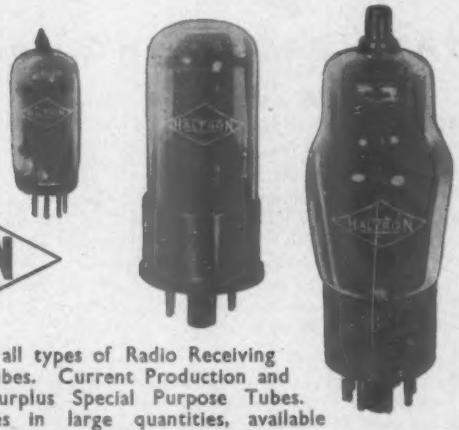
SURVEYED · PLANNED · INSTALLED · MAINTAINED

MARCONI'S WIRELESS TELEGRAPH CO. LTD., MARCONI HOUSE, CHELMSFORD, ESSEX.

STRICTLY EXPORT ONLY



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Leading Exporters of all types of Radio Receiving and Transmitting Tubes. Current Production and Ex-Government Surplus Special Purpose Tubes. Over 400 types in large quantities, available Ex-Stock. Suppliers to Foreign Governments, Airlines, etc.

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★ **MANHOURS**
Warning signals operated in conjunction with your clock sound system save manhours otherwise lost in commencing work, job costing, shift changing, clocking off, etc.

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★ **MONEY**
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but it must be **RELIABLE** Sound!
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TWIN SPEAKERS

The advantage of using a "separator" for dividing bass and treble between two speakers is now fully recognised, and is a system used in various highly priced reproducers. Webb's offer combinations of speakers and cross-over units at a reasonable cost.

Bass and middle reproducer Vitavox "K12/20"	**£11. 0. 0**
Treble Reproducer Stentorian "S812" 15 ohms	**£ 1.17. 0**
Webb's Type Cross-over Unit	**£ 3. 7. 6**
(Plus packing and carriage).	**£16. 4. 6**

(**NOTE** :—While existing stocks last we can offer the famous Vitavox "K12/20" 12in. L.S. unit, 18/20 watts, at the old price of £11. It is now listed at £14.)

Full details of Webb's Cross-over Units with circuits for home connection if desired, given with Webb's Catalogue 10d. post free.

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Webb's always have available a useful range of leading Manufacturers' Service Gear such as —

AVOMETER "MODEL 7". Probably the best known and most widely used meter in the world, accepted as a standard by laboratories and Government Depts. everywhere **£19.10. 0**

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to be held at their Showrooms on and after Monday, 1st October, 1951.

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A representative range of Signal and Audio Generators, Pattern Generators, Oscilloscopes, Constant Voltage Transformers and Test Meters will be shown in actual operation and expert Consultants will be in attendance.

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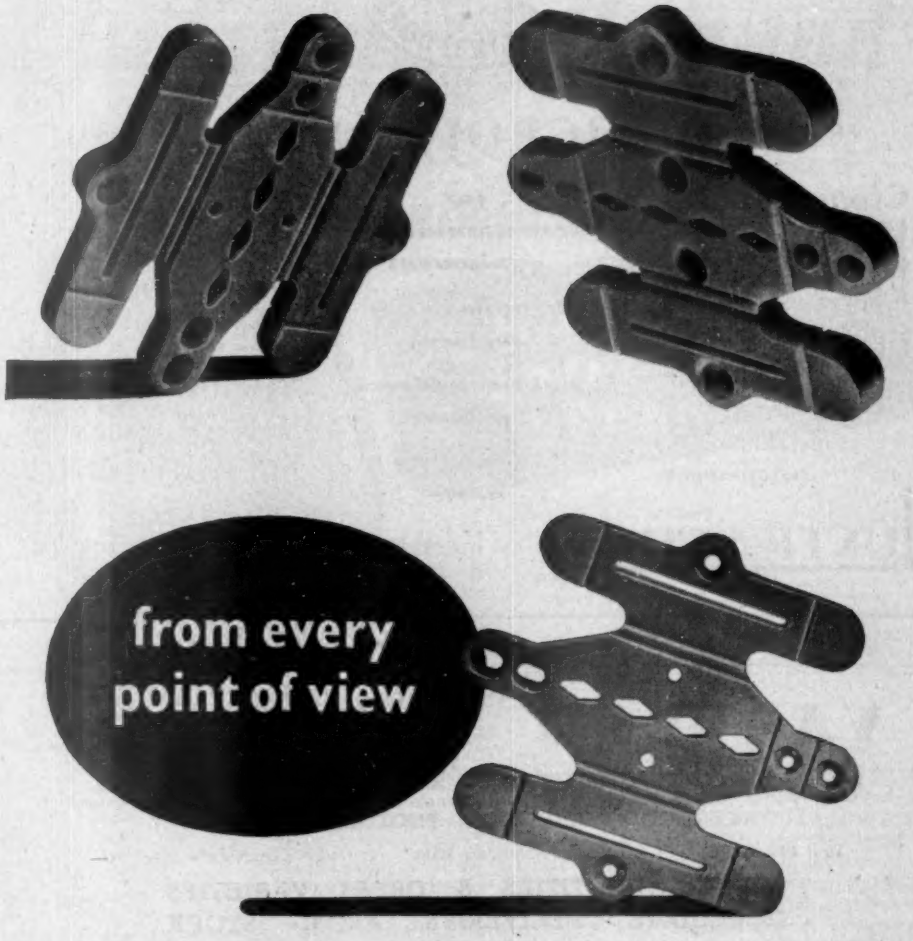

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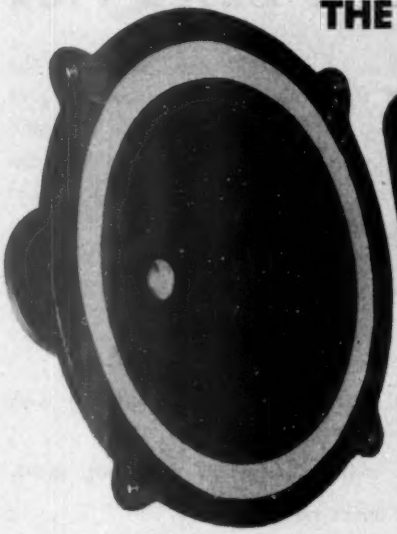

The BAKERS 12" "TRIPLE CONE" SPEAKER

Cone type	"Triple"
Effective cone dia.	9in.
Suspension	Cloth
Voice coil dia.	1½in.
Coil impedance (to order) Standard	15 ohms
Flux density	15,000 lines sq. cm.
Frequency range	20/15,000 c.p.s.
Natural resonance	35 c.p.s.
Max. peak input	10 watts

Price £8 : 5 : 0

This amazing Reproducer, known the world over, requires little introduction. The unique diaphragm assembly is comprised of three cones which, used in conjunction with an extremely powerful magnet system, control completely the brilliant upper register down to the lowest note of the organ, with perfect ease. This enables a class of reproduction to be obtained which will delight and thrill the heart of every music lover. If you are not fully conversant with all the ingenious constructional details of this High Grade Reproducer, you should write without delay for Descriptive Leaflets—or better still call for an audition of: "BAKERS" SPEAKERS, RECEIVERS and AMPLIFIERS, the combination of which offers the highest possible QUALITY REPRODUCTION obtainable.

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Also Available :

12" Single Cone and 18" Duplex Speakers and High Class Amplifiers and Receivers for Home use and Public Address.

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for CO-AXIAL CABLES

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BRIEF SPECIFICATION

These Plugs and Sockets are manufactured to an R.E.C.M.F. Specification, and the minimum performance figures after testing to RIC/11 Yellow Specification INCLUDING TROPICAL EXPOSURE TEST, are :—

Capacity (Plug and Socket together)	5 pF max.
Contact Resistance (Outer Contacts)	10 milliohms max.
Contact Resistance (Pin Contacts)	10 milliohms max.
Leakage Resistance	10 Megohms min.
Steady withdrawal force	6-16 lb.

PAT. NO. 637613

ANTIFERENCE LIMITED · 47 BRYANSTON STREET · LONDON W.1

IT'S EASY TO TELL "TELECENE" Activated Rosin Based Flux

There's no mistaking TELECENE, the liquid flux specially formulated to give rapid and efficient dip-soldering and pre-tinning of electrical and radio components.

Telecene is the fluxing medium that fulfils all the conditions imposed by modern manufacturing techniques :—

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1 **it wets the surface quickly and completely.**

2 **it contains a *soluble* activating agent.**

3 **it needs no stirring.**

4 **it is non-corrosive.**

5 **it is equally suitable for mass production or the smallest individual soldering jobs.**

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Telecene is manufactured by the makers of

Superspeed Activated Rosin Cored Solder

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With over 70 different types in our range, and equivalents for most other manufacturers' cells, we are in a position to solve your photo-cell problem.

Full technical information is available on application to:—

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A Company within the J. Arthur Rank Organisation

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Plays 5,000 times without replacement

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No. 2 — STRAIGHT for use with Standard or Crystal Pick-up

No. 3 — LIGHTWEIGHT for use with Miniature Pick-up

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PRICE 6/6 TAX PAID

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The need for competitive prices has not been overlooked. Our long experience and modern facilities enable us to keep production costs down to the lowest possible level. If, then, your requirements are for transformers with assured reliability at reasonable cost, we are at your service.

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(If ex-R.A.F. or W.A.A.F. please give rank, trade and number)

★ If you are 14-17—and keen—join the Air Training Corps ★

DYNATRON

have pleasure in announcing the new 1952 Ether Conqueror Series V Radio and Radiogramophone chassis, tuner type T99 and Amplifier Type LF612. These chassis are used in the Merlin Radjo Console, Regency and Queen Anne Radiogramophones.

TUNER T99

9 valves — all glass based.
4 wavebands — 10-32, 30-85, 180-570, 800-2000 metres.
Special models for export.
Variable Selectivity — four positions 5-10-15-20KC.
I.F. bandwidths.
Independent Bass and Treble controls.
Spin tuning, calibrated band spreader.
Pre-set whistle filter.
Large tuning dial 13" x 9".

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6 valves.
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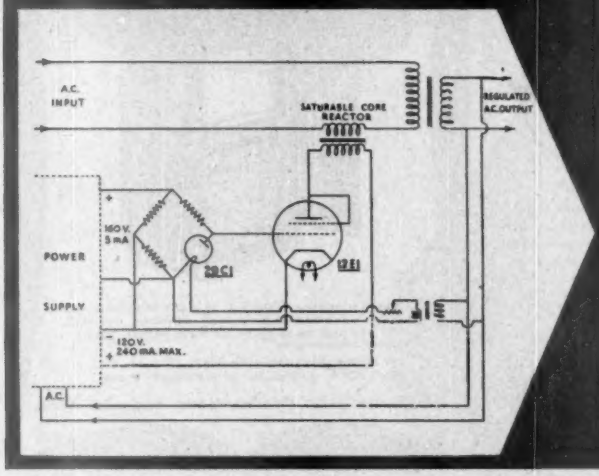
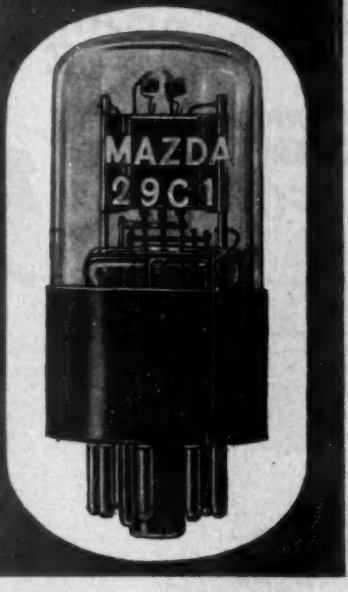
THE EDISWAN MAZDA — 29C1





The Ediswan Mazda 29C1 is a high vacuum directly heated tungsten filament diode suitable for use as the controlling element in stabiliser circuits.

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Approximate Filament voltage (volts)	4.0
,, ,, current (amps)	0.8
Maximum Anode current (mA)	3.0
,, ,, voltage (volts)	100

DIMENSIONS	
Maximum overall length (mm)	80
Maximum diameter (mm)	32
Maximum seated height (mm)	67

TYPICAL OPERATION	
Saturated anode current (mA)	2.0
Minimum anode voltage (volts)	20.0
Approximate Filament voltage (volts)	4.0
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Base I.O.8

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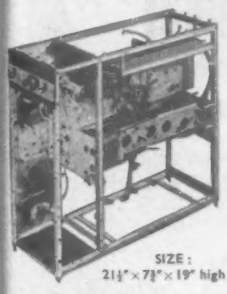
HOW TO DESIGN 'NEAR UNIT' APPARATUS USING THIS CHASSIS AS A BASIS



SIZE: 21½" × 7½" × 19" high

1—Lower Section of Unit already fitted with 10-pin Plug Strip fitting sockets of the ex-U.S.A. TUB Tuning Units for conversion to Receiver.

2—This leaves room at right of panel to take the ex-R.A.F. RF Units 27 or 28 used as convertors feeding into receiver.

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4—When the internal aluminium chassis is removed, the top section of the frame will take another TUB unit for conversion to Transmitter.

5—Leaving the top right-hand Antennae Tuning Panel and space behind it ready made for this or for fitting other apparatus required.

Average Contents (all new and unused).

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4 100 ohm. 1-watt Resistors.
2 600 v. 1 mf. Condensers.
9 High-voltage Condensers .0001 to .01.
1 3-way Switch.
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1 Ceramic Valve Holder.
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Spring Terminals.
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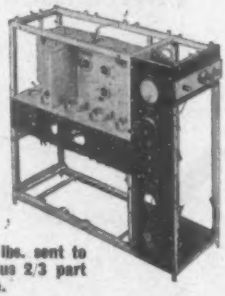
Innumerable Nuts and Bolts, Soldering points.
Stand-off Insulators, etc., etc.



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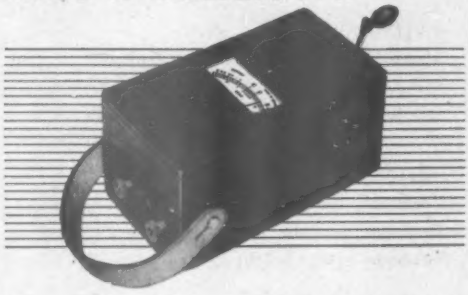

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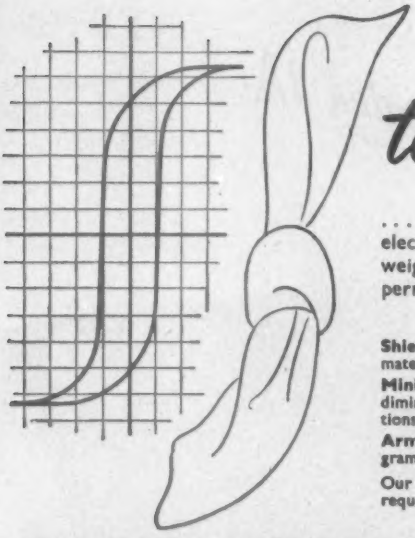

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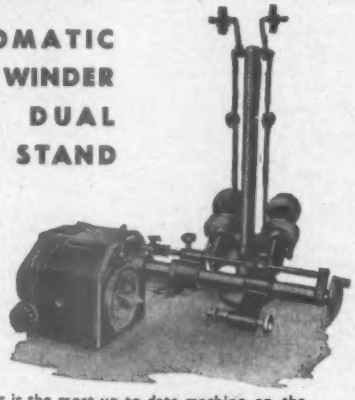

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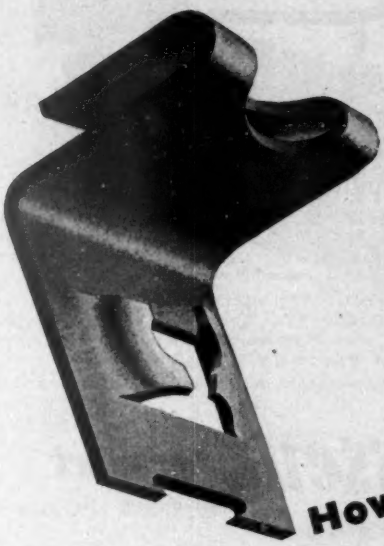

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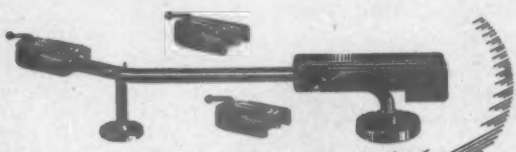

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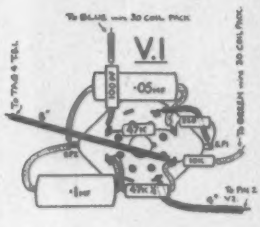

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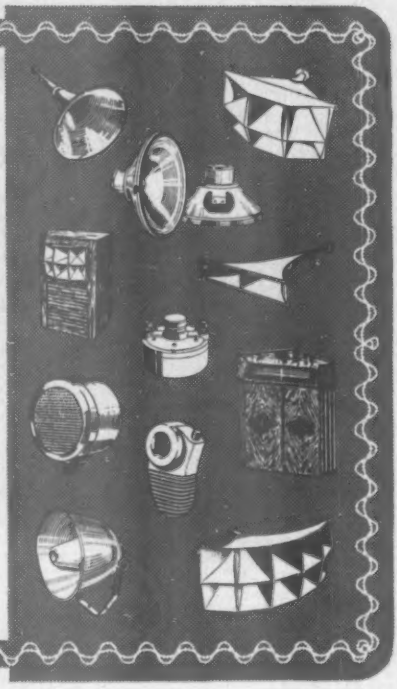

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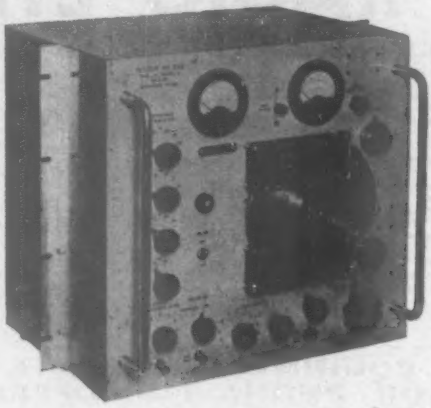

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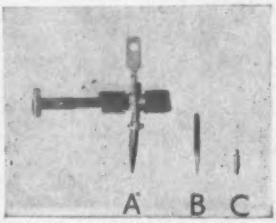

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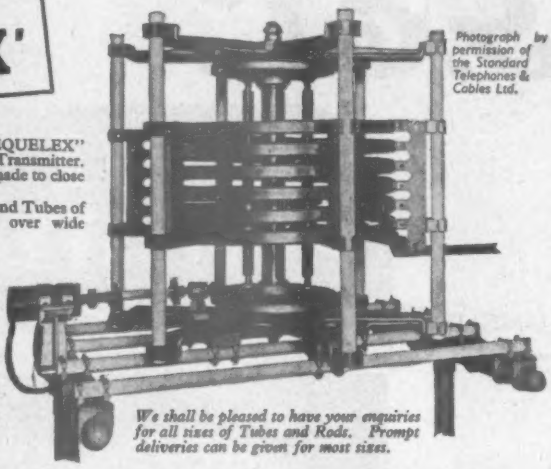

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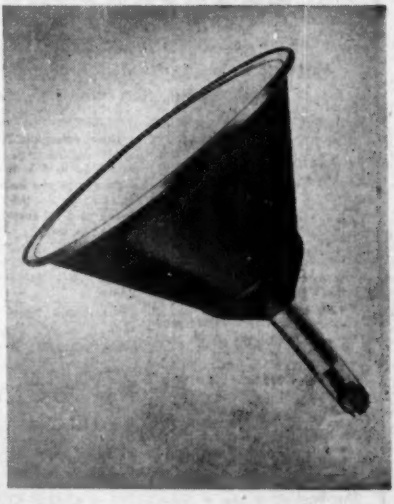

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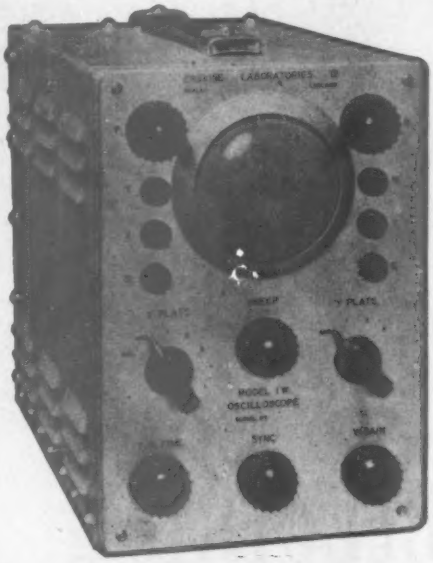

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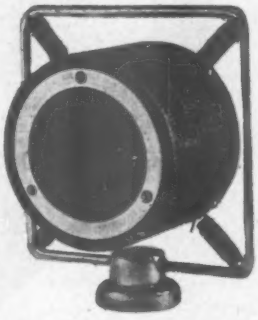

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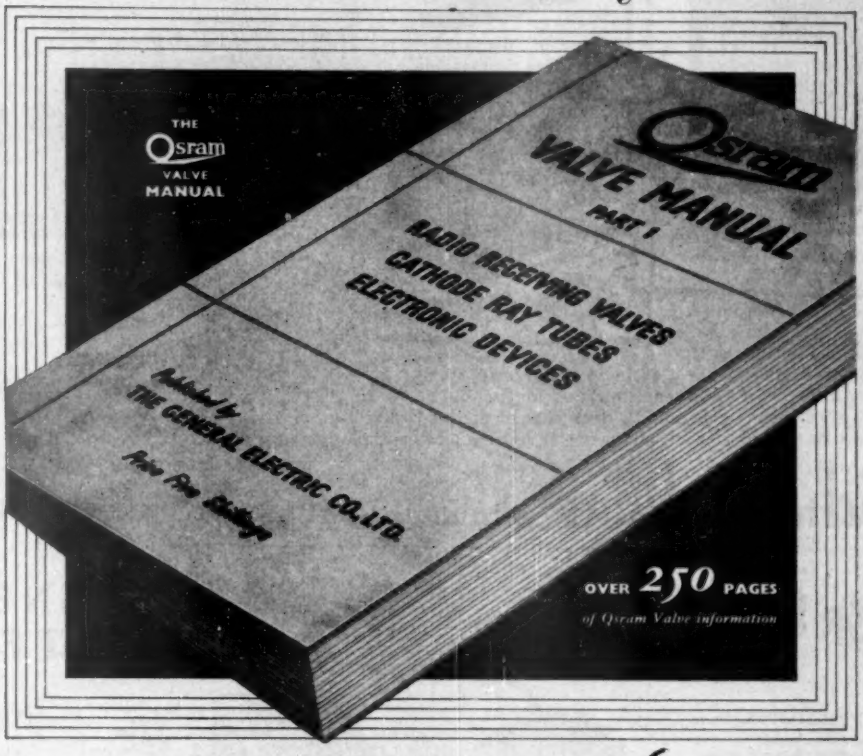

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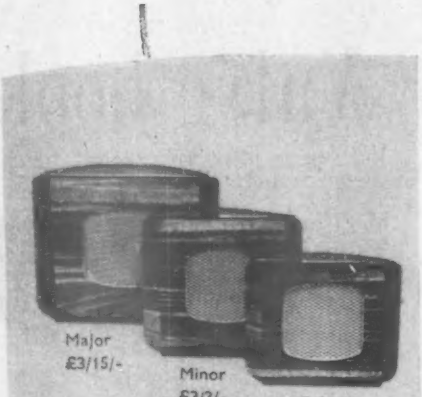

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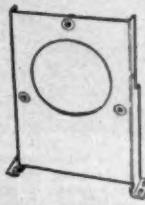

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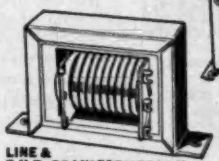

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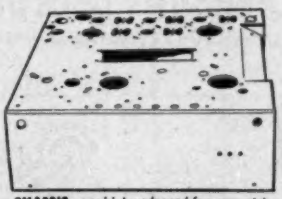

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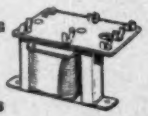

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The Wolf Automatic Soldergun, with its auto-feed, trigger solder-feed action, is indispensable to all modern assembly.

For all who, for special reasons, prefer the conventional straight type handle. Identical as regards elements and bits to Wolf Solderguns but with round hard wooden handle with heat deflecting skirt.

★ *Obtainable from all high class stockists and ironmongers*

It pays to Solder with

Wolf *Electric* SOLDERGUNS & SOLDERING IRONS

WOLF ELECTRIC TOOLS LTD. PIONEER WORKS, HANGER LANE, LONDON, W.5. Tel.: PERivale 5631-4. Branches: BIRMINGHAM, MANCHESTER, LEEDS, BRISTOL, GLASGOW

SIFAM

Precision INSTRUMENTS

Thermo-couples are available, complete with 4 ft. compensating leads.

Portable

PYROMETER

A high-grade, 3½" scale moving coil instrument, robust, accurate and speedy in response. Normally supplied with 2 scales, 0-200°C and 0-400°C, and 3 surface couples. Also supplied with ranges up to 1,600°C for all standard thermo-couples.

For details of this and other SIFAM instruments, write for new catalogue to :—

SIFAM ELECTRICAL INSTRUMENT CO. LTD.
LEIGH COURT, TORQUAY. Telephone : Torquay 4547-8

RAINBOW radio & television

T.V. FREQUENCY CONVERTER

Model HM2. 2-valve model. self-contained power unit, enables immediate change-over SUTTON COLDFIELD tuned receivers to HOLME MOSS reception, without ANY alteration to chassis, etc. Price £8.0.0.

T.V. PRE-AMPLIFIERS

One-valve model, self-contained power unit, £5.17.6. TWO-valve model, self-contained power unit, for EXTREME fringe areas, £7.10.0. Extremely efficient. Many thousands in use.

Your dealer will be pleased to demonstrate.

Illustrated leaflets giving technical specification, etc., forwarded with pleasure, write: Manufacturers

RAINBOW RADIO MANUFACTURING CO. LTD.
Mincing Lane, Blackburn, Lancashire

PRECISION MEASUREMENTS IN LINE TRANSMISSION

In the measurement of losses and gains greater accuracy can be achieved if a visual instead of an audible means is employed. The illustration depicts an electronic voltage comparator in which a cathode ray tube is used as an indicator of the relative magnitudes of a standard signal and the unknown signal to be tested. In the position of maximum sensitivity an input signal of 30 microvolts will give a 1 cm deflection on the screen which allows a comparison accuracy equivalent to 0.1db. Measurements can be made from 100 c/s to 200 Kc/s. This instrument, which is extremely simple to operate, is used as the sensitive detector in the measurement of losses in channelling equipment, amplifier gains, crosstalk and harmonic distortion in amplifiers, etc.

Distributor

AUTOMATIC TELEPHONE & ELECTRIC CO. LTD.

(Radio and Transmission Division), Strowger House, Arundel St., London, W.C.2

Telephone: TEMple Bar 9262. Cablegrams: Strowgerex, London.

Manufacturers

AUTOMATIC TELEPHONE & ELECTRIC CO. LTD., Liverpool & London

TELEPHONE MANUFACTURING CO. LTD., St. Mary Cray, Kent

ATE/TMC

A8411-B.265

Mullard GENERAL PURPOSE OSCILLOGRAPH TYPE E805

This Cathode Ray Oscillograph is for general purposes. But it incorporates many features not normally found in such instruments. It covers a very wide range of frequency, including the whole frequency spectrum used in television. And it's equally well suited for research work, production testing or transmission monitoring. Many of Industry's high frequency problems can be solved with this oscillograph's aid — particularly those problems of motor-car ignition, flash-over on insulators, discharge at high voltages, etc.

- 3½" cathode ray tube with 1,250 volt final anode potential.
- Beam modulation. External blanking of beam for timing purposes and eliminating retrace.
- Beam suppression prevents "fogging" of film when camera shutter is open.
- Single stroke operation for non-recurrent phenomena or photographic recording.
- Calibrated step-type input attenuator with coarse and fine adjustment.

The Mullard Cathode Ray Oscillograph, type E.805. Dimensions: Height 14" ; Width 9" ; Length 15½". Please write for detailed information.

SPECIFICATION

Amplifier. Gain 1,400 or fmV rms/cm. Frequency range 2 c/s-2 mc/s. 3 dB loss.

Attenuator. Stepped 5-10-20-35 mV cm. Multiplier x 1, x 10, x 100 x 1000. Maximum input 250 V. rms.

Time Base. 5 c/s-150 Kc/s in 10 steps with continuous variation between steps.

NORTHERN AGENT: *F. C. Robinson & Partners, Ltd., 287, Deansgate, Manchester, 3*

MIDLAND AGENT: *Hadley Sound Equipments, 72, Cape Hill, Smethwick.*

SCOTTISH AGENT: *Land, Speight & Co. Ltd., 73, Robertson Street, Glasgow, C.2.*

Mullard Ltd., Equipment Division, Century House, Shaftesbury Avenue, London, W.C.2. Telephone: Gerrard 7777

(MI.358)

CONSTANT VOLTAGE POWER SUPPLY UNITS

MODEL 101-C

Output: 250/400v. 0.250mA max.
Stability: Better than 0.1%.
Output Impedance: Less than 1 ohm.
Output Ripple: Less than 2mV. R.M.S.
Mains Supply: 200/250v. 45-60c/s.
Regulation down to zero load.

DETAILS ON REQUEST.

ALL-POWER TRANSFORMERS LTD.
CHERTSEY ROAD, BYFLEET, SURREY.
Tel: Byfleet 3224/5.

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have now been acquired by

COLE-BERNARD PRODUCTIONS LTD

of

295 MUNSTER RD., FULHAM, S.W.6

The trading title of "BERNARD'S" is being retained.

All items in the classified advertisements and previous quotations by Messrs. Bernards are now available on

HIRE PURCHASE TERMS

ALL ENQUIRIES TO NEW ADDRESS

PREMIER RADIO COMPANY

B. H. MORRIS & CO. (RADIO) LTD.

BRAND NEW R1155 RECEIVERS, in original cases, complete with 10 valves, £12/10/-, 7/6 packing and carriage.

BRAND NEW R1355 RECEIVERS, in original cases, as specified for the "Inexpensive Televisor," complete with 11 valves, £2/15/-, 7/6 packing and carriage.

BALANCED ARMATURE LOW RESISTANCE HEADPHONES: Type 1, 5/11 set; Type 2, 7/11 set.

HIGH RESISTANCE HEADPHONES, 12/6 set.

MOVING REED HEADPHONES, Type 5, 8/11 set.

TANNOY HAND MICROPHONES, with switch in handle, 4/11.

ACCUMULATORS, by world-famous maker, 2 volt 10 a., 4/11.

BURGOYNE SOLDER GUNS, 75/-.

T.R.F. COILS
180-550, 800-2,200 metres, pair 6/6.

H.T. ELIMINATOR AND TRICKLE CHARGER KIT
All parts to construct an eliminator to give an output of 120 volts at 20 mA, and 2 volts to charge an accumulator. Uses metal rectifier, £2.

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We can supply the Kit of Parts for the latest version of this famous amplifier complete in every detail for £10/10/-, with valves, output and mains transformers.

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All incorporate metal rectifiers. Transformers are suitable for 200/250 v. A.C. 50 cycle MAINS.

Cat. No.		
2002	Charges 6 volt accumulator at 1 amp. Resistance supplied to charge 2 v. accumulator	£1 2 6
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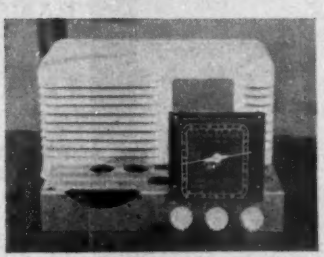
These tubes are new but have slight cut-off, 19/6, plus 5/- packing, carriage and insurance.

THREE-PIECE AERIAL
Ex-U.S.A. copper-plated steel, highly flexible with non-stick screw joints, tapering ¾in. to ¼in. Brand new, in container, 6/9, packing and carriage 1/6.

MAINS NOISE ELIMINATOR KIT. Two specially designed chokes with three smoothing condensers with circuit diagram. Cuts out all mains noise. Can be assembled inside existing receiver, 6/- complete.



GIVE YOUR HOME-BUILT RECEIVER THAT PROFESSIONAL LOOK

We can supply all the parts to help you.

Bakelite cabinet (brown or ivory) (pkg. and insce. 2/6)	17/6
Punched Chassis: 3 valve plus rectifier T.R.F. or 4 valve plus rectifier, superhet	3/9
Engraved Glass Dials: 16-50 and 180-550 metres or 180-550 and 800-2,200 m., or 16-50, 180-550 and 800-2,200 m. ..... each	1/-

All with station names, new wavebands.

CORD DRIVE ACCESSORIES

Drum (2½in. diam.)	1/-
Driving Head	1/-
Double Pointer	4d.
Spring	3d.
Nylon Cord (yard)	6d.
Dial Back Plate	2/6

We can supply a Premier Circuit Diagram and Price Parts List showing how a 3 v. TRF A.C. Mains Receiver can be built at a total cost of £5/19/6, the Circuit Diagram can be supplied at 1/6.

T.V. WHITE RUBBER MASKS (CORRECT ASPECT). We can supply a specially designed White Rubber Mask for 6in. C.R. tubes at 8/6 each.
9in. White Masks, 9/6. 12in. White Masks, 16/11. Round or flat faced.

SORBO RUBBER MASKS, GREY FELT FINISH (NEW ASPECT RATIO).
9in., 5/-; 12in., 9/6.

P.M. MOVING COIL LOUDSPEAKERS
(3 ohm voice coils)

2½in. Goodmans	15/-
3in. Plessey	15/-
5in. Plessey	12/6
5in. Truevox	12/6
5in. Rola	13/6
6in. Truevox	12/6
8in. Plessey	14/6
10in. P.M.C.	27/6
12in. Truevox	70/-

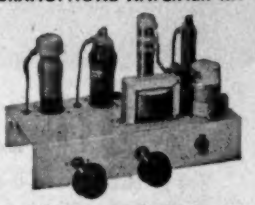
Please add 1/6 for post orders under 40/-, 1/- under 20/-. Cash with order or C.O.D.

SUPERHET COILS
16-50, 180-550, 800-2,000 metres, set, including circuit 10/6

BRAND NEW CAR BATTERIES
Delco-Remy, in original cases
6 v. 100 a., £4/17/6, plus 7/6 carriage and packing.
6 v. 140 a., £5/10/-, plus 7/6 carriage and packing.
12 v. 85 a., British made, £5/10/-, plus 7/6 carriage and packing.
6 v. 170 mA., in teak case, £5/10/0, plus 7/6 carriage and packing.

SUPER QUALITY TELEVISION MAGNIFYING LENS. To suit 5in., 6in., or 7in. Tubes. Increase picture size considerably, 25/- each.

GRAMOPHONE AMPLIFIER KIT



Consists of complete Kit of Parts for a 2½-watt Mains-operated 2-stage Amplifier for use with any type of pick-up. Volume and tone controls are incorporated. Output impedance is 3 ohms. Cat. No. AMP147. Price complete, 59/6. For 200-250 v. mains with valves and diagrams.

GRAMOPHONE UNITS

Collaro Auto-changer, 3-speed, including 2 crystal heads, 1 long playing, 1 standard	£18 14 1
Connoisseur 2-speed Gram Unit, less pick-up	£20 19 3
Pick-up and 2 heads for above	£9 6 4
Conrad Rim Drive Gram Unit, less pick-up, 78 r.p.m.	£4 3 10
Conrad Rim Drive Gram Units, 33 r.p.m.	£4 7 5
Decca 3-speed Rim Drive Gram Unit, less pick-up	£7 3 4
Decca single-speed Rim Drive, less pick-up	£3 14 4

All the above are for use on A.C. mains only.

SENSATIONAL OFFER
The famous Dulci Midget Receiver for use on either A.C. or D.C. mains, 200/250 volt. This is a 2-waveband 4 v. Superhet Receiver covering the short waveband from 13.6 metres to 50 metres, and the medium waveband from 200-550 metres. Can be supplied in either ivory or brown bakelite cabinet.
Size 7¾in. length.
6in. height.
5¼in. depth.
This receiver is fully covered by the manufacturer's guarantee.
Price £8/15/0, carriage paid.
THIS OFFER CANNOT BE REPEATED

MOVING COIL METERS
(2½inch. outside diameter)

20 v. D.C.	5/9	20 amp. D.C.	7/6
40 v. D.C.	5/9	40 amp. D.C.	7/6

THERMO-COUPLED METERS

·5 amp.	5/-	4 amp.	5/-

300 VOLT D.C. MOVING COIL METER with shunt 10/-

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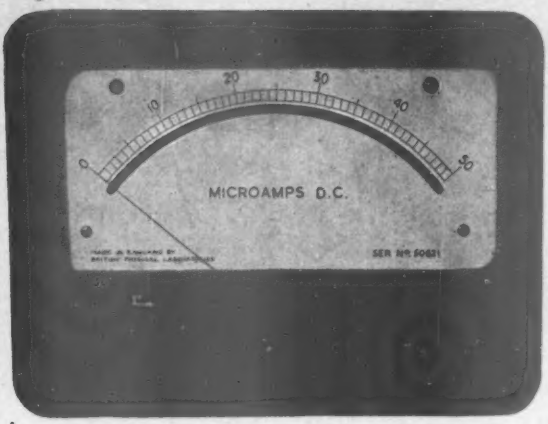
Phones: AMBassador 4033
PADdington 3271
PADdington 3272

Open every day until 6 p.m., including Saturdays. Closed 1 p.m. Thursdays.



SIZE	2½"	3½"	5"
RANGE	25μA to 50A	10μA to 50A	10μA to 50A

(Prices on application)

S.50 type Microammeters are stocked by Messrs. M. R. Supplies at New Oxford Street, London, W.1.

All sizes available with
MIRROR SCALE
1st Grade Accuracy

SENSITIVE PANEL MOUNTING METERS

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Because no radio receiver can give better reproduction than its loudspeaker permits, Celestion has always been the first choice of discriminating buyers. There is a comprehensive range of models with characteristics to suit all requirements. Write today for details.

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TRANSMITTERS 1154 3 band in transit case, £7/10/-, carriage paid.

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SPEECH AMPLIFIER (British made) for Transmitter R.C.A. ET4336, complete with all valves, **£26** ea.

BENDIX FREQ.-METERS TYPE BC221, complete £30 ea.

AR88 RECEIVERS (LF), **£50** each.

TUNING UNITS FOR BC375E TRANSMITTER. TU5-6-7-8-9-10 and 26B, 22/- each.

IDEAL 25-WATT TRANSMITTER, Army Type No. 12. Frequency coverage 1-17.5 Mc/s. in your switched bands, C.W. and phone, built-in modulator. Operated from A.C. mains 100-250 volts, complete with all tubes and delivered, £25 each.

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HALLICRAFTER MAINS TRANSFORMERS, for S20 Receivers, 32/6.

HALLICRAFTER OUTPUT TRANSFORMERS, for S27 Receivers, 22/6.

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Cables: Hallicraft, London. Phone: FULham 1803.

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LONDON CENTRAL RADIO STORES

DELIVERY FROM STOCK

SIMPSON
Moving Coil
OHMMETER

Two-range 0-2,000 ohms, 0-200,000 ohms. Size 3 in. × 5 in.

£2.17.6

RESISTANCE BRIDGE MEGGERS (Ex-Admiralty). Made by Evershed and Vignoles. 250 v. Range: Megger 0-50 ohms, Bridge .001-100,000 ohms, shown in four digit windows, 10/1 and 100/1 multiplier and divider. Size 9×8×6in. In leather carrying case. Carr. paid.

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WESTINGHOUSE METAL RECTIFIERS. Type H.T.10, 33 fins. Size 6×2½×2¾in. Carr. and packing 1/6.

15/-

PHOTO-ELECTRIC CELLS. Type G516. These cells are the gas-filled type with caesium Cathode. Made by Cintel. Minimum sensitivity 100μA/lumen working volts 100 D.C. or peak A.C. Projected cathode area 16 sq. cm. Suitable for 16 mm. Home Cinema Talkie equipment, Safety Devices, Colour and Photo. Matching, Burglar Alarms, Automatic Counting, Door Opening, etc. Brand new in original cartons.

42/6

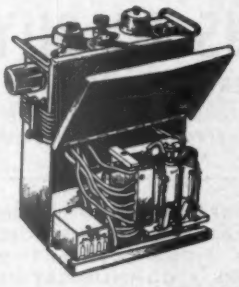
MOVING COIL MILLIAMMETERS Double reading 0-15 and 0-13. 2½in. diameter

12/6

ROTARY CONVERTER by E.A.C. Ball-bearing. 110 v. D.C. to 230 v. A.C. Size approx. 10×9×5in. Brand new. Carr. paid.

£13.5.0

TELESONIC 4-VALVE BATTERY PORTABLE (Fixed Range). Type YA4015.



Includes three XH and one XP Hivac midget valves. Can be adapted for Deaf Aid or Midget Receiver, but we do not supply information on this point. Batteries required 3 v. L.T., 97 v. H.T. In metal case, size 5½ × 7 × 2in. Weight 4lb., less batteries. Carr. and packing 2/6.

45/-

(Illustration shows chassis partly removed from cabinet.)

PHILCO
5-VALVE SUPERHET
RECEIVERS
FULLY RECONDITIONED & TESTED

90/- Table model in light or dark oak cabinet. Tone control, Pick-up sockets. Two-waveband. medium and long. A.C. or A.C./D.C. mains 200-250v.

120/- A powerful and selective two-waveband receiver with superlative performance on gramophone. Available in A.C. or A.C./D.C. mains working.

180/- **ALL-WAVE TABLE RADIO'** in attractive walnut cabinet' Pick-up sockets, additional socket for Dipole, P.U. and speaker sockets. An excellent receiver for Domestic or Amateur use.

All the above have built-in mains energised speakers. Cabinets approx. 19 x 13 x 10. Every set is overhauled before leaving our works.

The above prices include carriage and packing.

4-VALVE (*Used*) SUPERHET UTILITY RECEIVERS
Only 30 left !

2 wavebands, four valves, P.M. Speaker, complete in pine wood cabinet size 13½×12×6¼in. A.C. mains 200/250 volts. In good working order. Plus 7/6 carr. and pkg.

£4.10.0

UNISELECTOR SWITCHES

4-bank, full-wipers **37/6**
6-bank, half-wipers **27/6**
3-bank, full-wipers **19/6**

Have various applications, including automatic tuning circuit selection, etc. Operates on 25-50 v.

MAP READING TORCH. Powerful magnifying lens, 3in. diam. In bakelite case. Fitted with dimmer switch. Takes two U2 cells. With bulb, less batteries.

22/6

ONE ONLY !
H.M.V. RADIO AND TELEVISION CONSOLE

4 waveband, 6-valve Radio, 12in. Tube Television with indirect viewing (mirror in lid), handsome walnut cabinet of super quality, size 39in high × 19in. deep × 36in. wide. In perfect working order. Owing to size and weight **for callers only.** Price

£85

PHOTO ELECTRIC CELLS, Type CV143

Small infra-red image glass converter, tube, 50-100v. Suitable for all purposes.

14/6

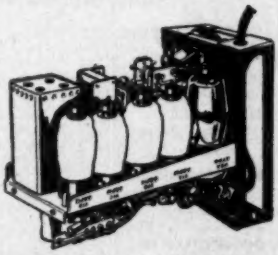
N.B.—We cannot enter into correspondence regarding these cells.

NEW NIFE ACCUMULATORS. 2.5 v. 2½ amp./hours for 8 hours. Size 3 × 4½ × 1¼in. (Flat) **6/6.** Post and packing 9d.

A Fine Opportunity!
New INERT CELL ACCUMULATORS

Everlasting. No acid or charging required. Suitable for battery sets, electric bells, etc. 1.5 v. **2/10** each. Post free.

WALKIE-TALKIE (Transmitter and Receiver) CHASSIS Type 38 Mk. II. Range 7.4-9 Mc/s.



Requires 3 v. L.T., 120/150 v. H.T. In perfect working order. Complete with four APR12, one ATP4 valves, one pair throat mikes, pair headphones and aerial. In metal case. Free wiring diagram. Batteries not supplied. Carr. and packing 2/6.

£3.8.6

Please Note: All carriage charges relate to Inland Orders only • We do not issue lists or catalogues

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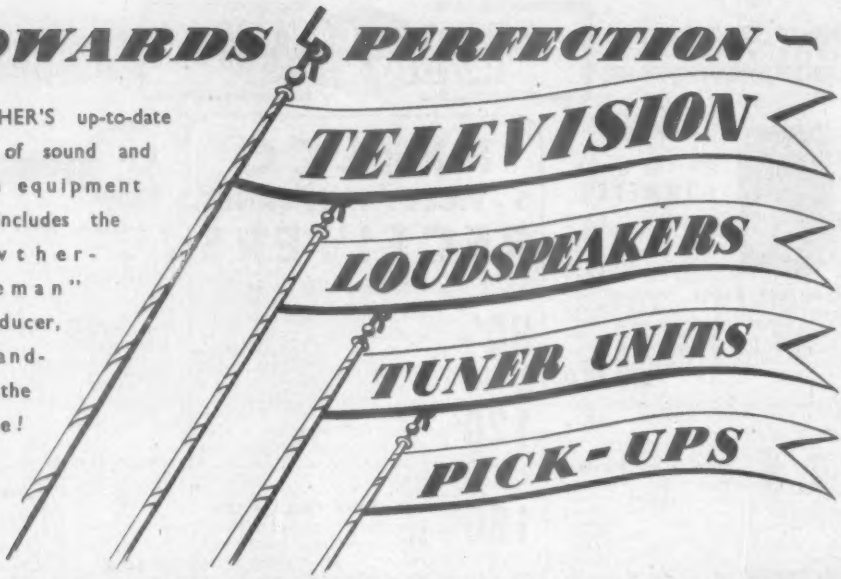
Closed Thursday 1 p.m. Open all day Saturday and weekdays 9 a.m.—6 p.m.

TOWARDS PERFECTION

LOWTHER'S up-to-date range of sound and vision equipment now includes the "Lowther-Hegeman" Reproducer, outstanding in the extreme!



THE LOWTHER MANUFACTURING COMPANY,
Lowther House, St. Mark's Rd., Bromley, Kent
Telephone : RAVensbourne 5225

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on EXHIBITION at
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Immediate delivery from stock

Export enquiries welcomed.

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Complete with Microphone £60 0 0

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Complete with Microphone £58 5 6

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33⅓ and 78 spd.... £3 14 4
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Models, HR2, 7, 8 ... £19 10 0
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ALL TAYLOR TEST GEAR IN STOCK. Still available on H.P. Send S.A.E for catalogue and terms.

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ALL AMERICAN MADE
GOVERNMENT SURPLUS EQUIPMENT
IN NEW OR GOOD SECOND-HAND CONDITION

TEST SETS • TRANSMITTING TUBES
CLYSTRONS • THYRATRONS • MAGNETRONS
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All kinds of American made surplus radio components and equipment.

We are interested in any quantity, from one upwards. Drop us a line and we will clinch the deal by return of post or send our representative to see you.

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dmAR 15

An Announcement . . .

DUREX ABRASIVES LTD. wish to announce that as from June 14th, 1951, the name of the Company has been changed, and is now the MINNESOTA MINING & MANUFACTURING COMPANY LTD. Identification will be as before, except that the words "Scotch Boy" will be used instead of "Durex" as a prefix to the name of the material, e.g., "Scotch Boy" Magnetic Recording Tape instead of "Durex" Magnetic Recording Tape.

Existing high standards in the quality of the products will be maintained, the change is in name only.

'SCOTCH BOY'

Magnetic Recording TAPE

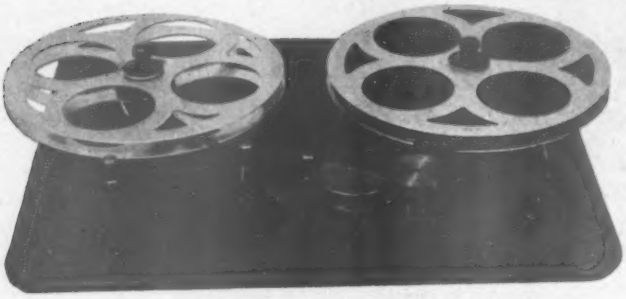
ANOTHER 3M COMPANY PRODUCT

Manufactured by :—

MINNESOTA MINING & MANUFACTURING COMPANY LTD

167, STRAND - LONDON - W.C.2 - AND SLOUGH

Qualtape Magnetic Tape Recorder



★ IMPROVED DESIGN
★ NEW FEATURES
★ PRECISION MADE
★ PERFECTLY BALANCED CAPSTAN DRIVE BY SEPARATE MOTOR
★ UP - TO - THE - MINUTE DESIGN. RECORD HEAD, PLAYBACK HEAD, TAPES STOCKED.

Complete Kit of Parts **£13-13s.**

FULL PARTICULARS ON REQUEST TO—

ELECTRONIC SERVICE
(HALLAMSHIRE) LTD.
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Telephone. Sheffield 21690

The Ideal Tape Recorder for home, office, board meetings. Make your own party records. Use it to improve musical and voice talent. Provide synchronised music and speech for home cine. All these and many more with "Qualtape." Only tools required—
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if so, we have in stock all the specified components to make this superlative amplifier

Partridge Mains Output Transformers
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T.C.C. Condensers
High Stability Resistors, 1% & 5%
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Matched valves
In fact "the works"

DETAILED PRICE LIST OF ALL COMPONENTS AVAILABLE ON REQUEST

TELE-RADIO (1943) LTD.
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Phone : PAD. 5606
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Shop Hours :
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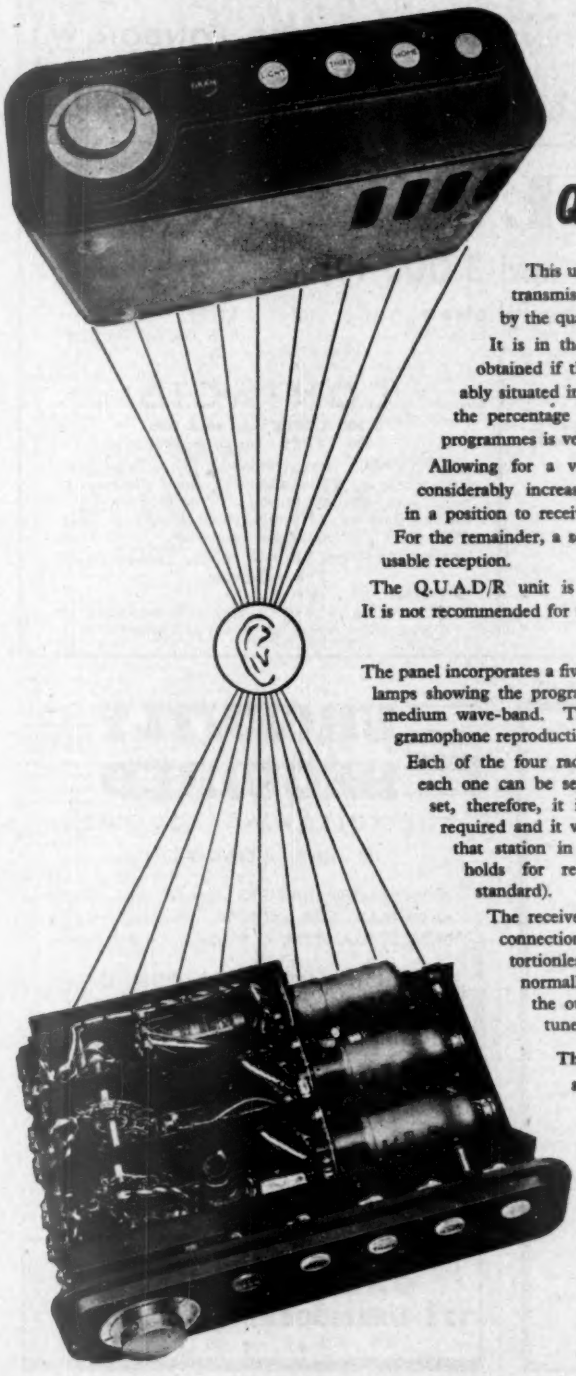
★ really comprehensive range of **Engraved Control Knobs!**

Beautifully engraved Control Knobs in either Walnut or Ivory. Each knob is engraved in GOLD which is given an adhesive base, thus rendering erasion impossible. The range of inscriptions is the most comprehensive on the market—the markings being decided upon only after extensive enquiries throughout the trade. The requirements of every RADIO, TELEVISION and AMPLIFIER enthusiast are catered for. Inscriptions obtainable are BRILLIANCE, CONTRAST, FOCUS, BRILLIANCE/ON-OFF, VOLUME, VOL/ON-OFF, TREBLE, BASS, TUNING, TONE, RADIO-GRAM, WAVECHANGE, ON-OFF. Packed individually in transparent envelopes.

Retail Price 1/6 each from your usual Dealer.

Distributors :
UNCLES, BLISS & CO., LTD.
139, Cherry Orchard Road, East Croydon, Surrey



The Acoustical Q.U.A.D/R Tuner Unit

This unit is primarily designed to receive local broadcast transmissions at a standard of reproduction limited only by the quality of the transmission itself.

It is in the nature of things that this quality can only be obtained if the geographical position of the receiver is favourably situated in relation to the transmitter. In the British Isles, the percentage of the population so situated for all three main programmes is very low.

Allowing for a very small degradation of quality, the range is considerably increased and something over half the population is in a position to receive at least two programmes at high quality level. For the remainder, a severe cut in quality is essential in order to obtain usable reception.

The Q.U.A.D/R unit is suitable for those in the first two categories. It is not recommended for those in the third group.

★ ★ ★

The panel incorporates a five position rotary switch together with five indicator lamps showing the programme selected. Three of the positions cover the medium wave-band. The fourth covers long waves and the fifth is for gramophone reproduction.

Each of the four radio channels is separately tuned at the back and each one can be separately set for selectivity and sensitivity. Once set, therefore, it is only necessary to switch to the programme required and it will be received at the highest possible quality for that station in the area where the receiver is used (this only holds for reception conditions above a certain minimum standard).

The receiver is supplied complete with plugs, etc. for direct connection to a Q.U.A.D amplifier. In view of the distortionless detector which is used, the tuner unit is not normally suitable for use with other amplifiers because the output level is very much lower than conventional tuner units.

The Q.U.A.D/R Tuner Unit, complete as illustrated £26 (incl. tax)

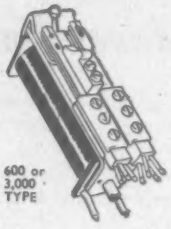
Full details are now available.

ACOUSTICAL MANUFACTURING CO LTD

HUNTINGDON • HUNTS • TEL: 381

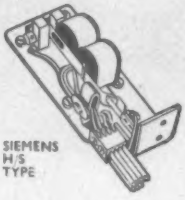
ALEC Davis SUPPLIES Ltd.

DEPT. W.W.
18 TOTTENHAM COURT ROAD, LONDON, W.1
Tel : MUSeum 2453 Tel : MUSeum 4539
Shop hours : Monday - Friday 9—5.30. Saturday 9—1.
FULL MAIL ORDER FACILITIES. Please add postage.



RELAYS

P.O. 600 and 3,000 types as follows :



D.C. COIL RESISTANCE

3,000 TYPES : 1.9Ω to 80,000Ω

600 TYPES : 0.4Ω to 9,200Ω

ALSO LARGE STOCKS OF DOUBLE- & TRIPLE-WOUND AND SLUGGED COILS.

CONTACTS

3,000 TYPES : up to 8 sets.
600 TYPES : up to 4 sets.

3,000 TYPES : Make (M), Break (B), in Twin-silver, Twin-platinum, Dome-silver (2 amp.), Tungsten (5 amp.), and Flat-silver (8 amp.). Change-Over (C), in all but Tungsten : Make-Before-Break (K), in Twin-silver and Twin-platinum.

600 TYPES : (M), (B), and (C), in Twin-silver and Twin-platinum.

SPECIAL
3,000 type Relays with 80,000Ω coils operating on approx. 600 μA with up to four sets of contacts.

1 KW TELEGRAPH TRANSMITTERS. Two HF 300's output. Operation 3.5 mc to 16 mc.

RCA TRANSMITTERS. Type ET-4336. Complete with matched speech amplifier, crystal multiplier and VFO units. Brand new.

LM-300 TRANSMITTERS (U.S.A.). 140 kc to 400 kc and 650 kc to 1,600 kc. 300 watt output.

No. 12 TRANSMITTERS. With coupling units, remote control etc.

AR.-77's, AR.-88's, NC 200, NC 45.

AUTOMATIC HIGH SPEED TELEGRAPH EQUIPMENT. "BOEHME" (U.S.A.). Up to 400 signs per minute on line and wireless.

NAVY MODEL TBY-8 TRANSMITTING-RECEIVING EQUIPMENT. Output 0.75 watts on M.C.W. telegraphy and 0.5 watts on telephony. Frequency range 28-80 mc.

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All above items in excellent working condition.

Working demonstration upon request.

TX VALVES 805, 807, 813, 814, 861, 866A, DET-16 and many others.

Large stock of Tx condensers, crystals and other components. Alignment and repair of communication receivers and all other short-wave equipment undertaken.

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Receiver Division:—
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URGENTLY REQUIRED

THE FOLLOWING EQUIPMENT IN ANY CONDITION :—

SIGNAL GENERATORS Type TF.144G, TF.390F or G, TF.517, 605B and 804B. Ex-Govt. types 30, 31, 51, 52, 52A, 53, 56, 57, 101, 103, 106 and others.

FREQUENCY METERS Type BC221, TS.174/U TS.175, TS.69AP, and other types.

AMERICAN TEST SETS Type TS.10, TS.13, TS.16, TS.33, TS.35, TS.36, TS.45, TS.47, TS.59, TS.62, TS,110, TS,118, TS,146, TS,263 and others.

RECEIVERS Type S27, SX28, AR88 and others.

ALSO :—IMPEDANCE OR UNIVERSAL BRIDGES, OSCILLOSCOPES, "Q" METERS, VARIACS, OUTPUT METERS, ETC.

Please write, call or phone, giving price, condition, etc.

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Now available on all your requirements —

TO CALLERS ONLY

12in. Mazda CRM.121A or Mullard MW.31/17 Cathode Ray Tubes, for £5 cash and 12 monthly payments of £1/4/7.

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50/- cash, deposit and 6 monthly payments of 22/-.

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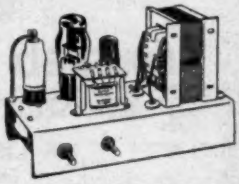
COLLARO AC504 MB Motors 78 r.p.m. £5.19.5
40/- cash deposit and 6 monthly payments of 19/6.

COLLARO U48 with Crystal pick-up 78 r.p.m. Universal Mains £13.15.2
85/2 cash deposit and 12 monthly payments of 19/6.

COLLARO 3 speed Auto Changer, in handsome cabinet £27.9.8
£8 cash deposit and 12 monthly payments of 36/6.

The above are some examples of terms available, but whatever your requirement is, we can supply on a generous h.p. payment scheme. Come and inspect our vast stocks of equipment and make your choice, or order in safety by mail. Enclose small securing deposit when making your enquiry or order to avoid disappointment if stocks are exhausted quickly.

HI-FI AMPLIFIER A1



For A.C. 200-250 v. only. Kit, incl. valves, for gramophone amplifier giving high quality reproduction. Simple instructions with many illustrations. Kit complete in every detail down to solder tags and solder. Pre-drilled chassis, group board with all resistors, condensers, etc.
Complete kit with instruction manual, £4/12/6. Instruction manual only, 3/6. Tone control kit, 5/-. Kit assembled **£5/12/6**

AMPLIFIER TYPE A2 for AC/DC 200-250 v.

Employs same fundamental circuit as the A1. Gives first-class reproduction. Kit complete in every detail.

Complete kit with instructions	**65/-**
Instruction manual only	**3/-**
Tone control kit	**5/-**
Kit assembled	**12/6**

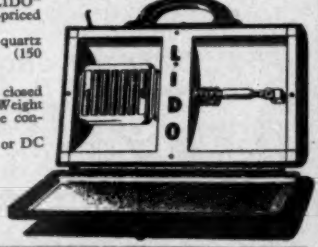
RADIO TUNING UNIT TYPE RF1.

Complete Medium Wave Radio Tuning Unit for use with A1 or other AC amplifier. A "straight" TRF circuit is employed using two high gain pentodes. Reproduction is excellent. High sensitivity means it may be used in areas of moderate signal strength.

Complete kit with instructions	**£2/12/6**
Instruction manual only	**2/-**
Kit assembled	**70/-**

H.P. Terms available on all above.

THE LIDO SUN LAMP



Sun Indoors through "LIDO"
The most powerful low-priced Sun Lamp ever offered.
1 Real high pressure quartz mercury generator (150 watts).
2 Radiant heat element.
3 Compact. Size when closed 12" × 7½" × 3". Weight 3¼ lbs. Suitcase type container.
4 Ready for use on AC or DC Mains.
5 12 months' guarantee.
PRICE £17. 11. 0 cash (including goggles) or £6 down and 12 monthly payments of 22/6.

NEW FULL VISION DRIVE ASSEMBLY

Vertical dial with new station markings on S., M. and L. wave bands (3 colours). Size of dial approx. 5in. by 7in. in "Perspex" with back illumination plate. Drive mechanism absolutely positive and non-slip, with nylon cord. Complete with assembly instructions. **21/-** Post free.

AERIAL CO-AXIAL CONNECTOR

The "BURGOYNE" development for efficient watertight co-axial cable connections for which we are sole distributors. Made of aluminium with Steatite insulation. Weight of assembled connector only 12 ozs. **18/6**

COME HOME ON A BEAM!

AMERICAN TYPE LONG BEAM FOCUSING TORCH Special concentrated beam. Nickel-plated. Adjustable focussing. 2 U2 Batteries. Spare bulb in base. Pull-out loop. **Type J.** Fully Guaranteed. Post free. **11/6**

MAGNETIC TAPE RECORDING

SPECIAL OFFER.
We are able to supply motors and recording heads etc. in component kits on generous H.P. terms. All equipment is of first quality only. A special cash price is also available.
Kit 1. Comprising 1 Tamsa Record/Playback head; 1 Tamsa Erase head; 2 B.S.R. type FP10 motors; 1 Tamsa 65 kc. oscillator coil; 1 reel Emitape and 1 spare reel. Deposit 74/- and 12 monthly payments of 16/8 or £10/14/- cash.
Kit 2. As Kit 1 but with additional high fidelity playback head for 3 head system. Deposit 93/6 and 12 monthly payments of 20/- or £13/13/6 cash.
Kit 3. As Kit 1 but with additional B.S.R. F.P.10 motor for 3 motor decks. Deposit 92/- and 12 monthly payments of 18/4 or £12/12/- cash.
Kit 4. As Kit 3 but with additional Playback head for 3 motor decks employing 3 head system. Deposit £5/11/6 and 12 monthly payments of 21/8 or £15/11/6 cash.
N.B.—Durex MCL-III tape may be substituted instead of Emitape for an extra 1/- per month or 10/- cash.

EKCO PENCIL IRONS

For those who have to do soldering in confined spaces, this iron provides the solution to easy scorch-free soldering. It is light in weight and having very low consumption will appeal to those who are tired of clumsy, heavy irons and exasperating electricity bills. For 6 or 12 v. operation. Please state voltage when ordering. BRAND NEW IN MAKER'S CARTONS. (Postage 1/6.) **£1/1/-**

Advance E2 Signal Generator £28 cash or **£9** deposit and 12 monthly payments of **£1/15/-**.
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Taylor Universal Meter 85A/P £18/10/- cash or **£6/10/-** deposit and 12 monthly payments of **23/6**.
Taylor Electronic Testmeter 170A £22/10/- cash or **£7/10/-** deposit and 12 monthly payments of **28/-**.
The above are some specimen offers on test equipment in stock.

AMPLION MAINS CONVERTORS

VPA	for A.C.	Output 80/90 v. H.T. and 1.25 v. L.T. **£4/10/-**.
DB3	200-240 v.	Output 90 v. 10 m/a. H.T. and 1.4 v. L.T. **£4/7/6**.
M2V		Output 100-140 v. 10/20 m/a. H.T. and 2 v.
	Mains	L.T. adjustable up to 1 amp. **£6/10/6**.
PRI	input.	Output 60/70 v. H.T. and 1.25 v./1.4 v. L.T. **£3/5/-**.

ELECTRIC TOOLS

Handy Utility ¼in. Portable Drill, for AC/DC mains **£6/10/-**
Horizontal Stand for above **17/6**
Buffing and Polishing Kit for above **19/6**
The Complete set described above for **£2/17/-** deposit and 6 monthly payments of **25/-**.
Wolf Flexible Shaft Electric Grinder, 2 speed, 2 positions. Type FP2, Operates on AC/DC mains at speed of 11,500 R.P.M. or 1,200 R.P.M. Accessories available. **£29/10/-** cash, or **£9** deposit and 12 monthly payments of **38/-**.
Burgoyne 7 Second Solder Gun, 79/6 or **20/-** cash and 6 monthly payments of **11/-**.

THIS MONTH'S SURPLUS OFFERS

VALVE VOLTMETER (Indicator Modulation Type 2). Complete with 0-500 Microamp D.C. moving coil meter. Calibrated for percentage modulation. Frequency coverage 2.4—6.2 Mcs. Easily convertible. In carrying case 11¼in. × 7¼in. × 6¼in. **32/6.**

AC/DC POWER PACK A very small power supply for use on any voltage between 97-250 volts A.C. or D.C. mains. Size 8¼in. × 3¼in. × 2¼in. Complete with mains tapping block and lead. Off load D.C. voltage output approx. 250 volts. On normal load for small superhet approximate output 100-120 volts. As used for M.C.R.I. receivers **29/6** (Post and packing 2/6).

R.1355 RECEIVERS Complete with valves. Just the job for the T.V. receiver, employing a VCR 97 tube. The complete receiver can be made on the chassis with very little alteration and the power unit can also be accommodated. 5 stages of I.F. amplification at 7 mc. 8, SP61s, 1. 5U4G, 1, VU120. Host of resistors and condensers. BRAND NEW ONLY **52/6**

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The Radio Centre

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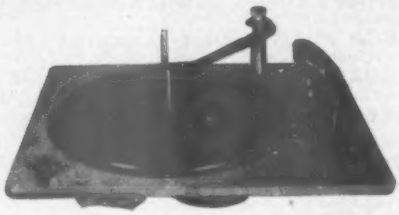
QUALITY PRODUCTS

The Collaro 3RC521 Record Changer

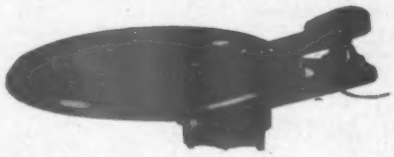
A completely automatic three-speed changer designed to play 33⅓, 45 and 78 r.p.m. records—with a minimum need for adjustments. Fitted with a pickup arm, suitable for all types of Collaro Plug-in heads. Beautifully made and completely foolproof.



The Collaro 3/514 Gramophone Unit

A brilliant three-speed unit which incorporates all the accepted Collaro features . . . patented 3-speed drive . . . spring suspension . . . plug-in pickup heads.

Both models mentioned are suitable for A.C. Supplies.



They're three-speed. They "Take all Records!"

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MAKERS OF FINE QUALITY GRAMOPHONE COMPONENTS, RECORD CHANGERS AND GRAMOPHONE UNITS, PORTABLE ELECTRIC GRAMOPHONES, INDUCTION MOTORS, PICKUPS AND PLUG-IN HEADS.

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The "RD JUNIOR DE-LUXE" Amplifier (KT66)

This improved version of our already well-known and popular "RD Junior de Luxe" now employs triode connected KT66s in the output stage, and features higher gain and improved power output.

Specification

Output:	10 watts maximum.	
Distortion:	at 1,000 cps. Not exceeding .25% at 8 watts.	
	Not exceeding .75% at 10 watts.	
Frequency Response:	± .25 DB	30-20,000 cps.
Sensitivity:	Radio.	250 m/V. for 8 watts.
	P.U. 78.	120 m/V. for 8 watts.
	P.U. 33.	100 m/V. for 8 watts.
Bass Control:	± 18 DB at 30 cps.	
Treble Control:	+ 12 DB at 20 kcs.	
	− 20 DB at 20 kcs.	
	(Relative to 0 DB at 1,000 cps.)	
N.F.B.:	20 DB main loop. Incorporating output stage, phase splitter, driver stage, and output transformer.	

PRICE £25.0.0 complete

Full details available on request.
Trade enquiries invited.

★NEW! All L.P. records promptly despatched by post. Orders over £2 post free, under £2 add 1/-.
Complete L.P. record catalogue, 1/6 post free.

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S.G. BROWN

Precision

Sapphire Needle

For high Fidelity of Reproduction with minimum of wear on the record

FIVE TYPES TO CHOOSE FROM

The above are designed and manufactured to suit all types of pick-ups.

No. 1. "**Miniature**" jewel tipped needle for *light-weight* pick-up.
No. 2. "**Straight**" jewel tipped needle for *crystal* pick-up.
No. 3. "**Trailer**" jewel tipped needle for *medium-weight* pick-up.
No. 4. "**Knee Bend Trailer**" jewel tipped needle for the older *heavy-weight* pick-up.
No. 5. "**Miniature Solid Sapphire**" needle for *light-weight* pick-up.

PRICES:—Nos. 1-4, 7/- *plus Purchase Tax* 3/1. *Postage* 6*d*.
No. 5, 9/3 „ „ „ 4/1. „ 6*d*.

Your local dealer can supply.
In cases of difficulty, apply direct.

A "TIP" WORTH TAKING

An interesting and instructive Brochure giving advice on the choice of a S. G. Brown precision Sapphire Needle to suit your pick-up will be sent on request. Write Department "W"

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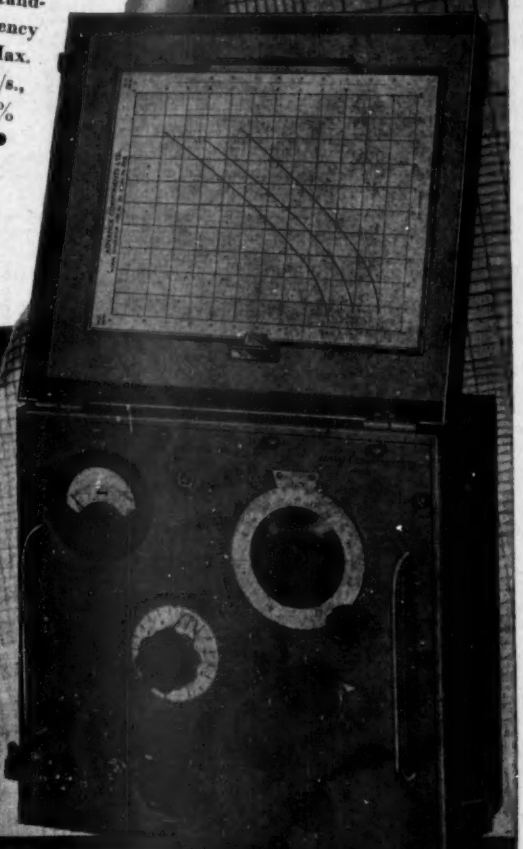
from 10 to 310 mc/s

Within the small compass of 14¼" × 12½" × 7¾", this generator provides facilities as are normally available only in instruments of much greater size and weight—and with an accuracy which suggests something far more costly. Outstanding features include:-Frequency calibration ± 1% ● Max. attenuation error at 300 Mc/s., ± 2db. ● Modulation 30% sine wave at 1,000 c/s. ● Negligible stray field ● Weight 34lb.

Fullest details contained in leaflet S6/W sent on request.



D1

Advance

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ADVANCE COMPONENTS LIMITED

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EARLY CLOSING DAY THURSDAY
ALL GOODS SENT ON 7 DAYS' APPROVAL AGAINST CASH

MAINS TRANSFORMERS. (New.) Input 200/250 volts in steps of 10 volts. Output 350-0-350 volts, 300 m/amps., 6.3 volts 8 amps. twice, 4 volts 4 amps., 5 volts 4 amps., 65/- each, carriage 3/6. Ditto, 450-0-450 volts 250 m/amps., 6.3 volts 8 amps. twice 4 volts 4 amps., 5 volts 4 amps., 65/- each, carriage 3/6. Another input as above. Output 500-0-500 volts 250 m/amps., 6.3 volts 8 amps. twice, 6.3 volts 4 amps., 4 volts 4 amps., 5 volts 4 amps., 70/-, carriage 3/6. Another, wound to (electronic) specifications, 350-0-350 volts 250 m/amps., 4 volts 8 amps., 4 volts 4 amps., 6.3 volts 8 amps., 0-2-6.3 volts 2 amps., 63/6 each, carriage paid. Another, input as above. Output 500-350-0-350-500 volts 250 m/amps., 6.3 volts 6 amps., 0-2-6.3 volts 2 amps., 0-4-5 volts 4 amps. twice, 67/6 each, carriage 3/6. **PRE-PAYMENT 1/- SLOT METERS.** 200-250 volts A.C., 50 cycles, 1 phase, set at 3d. per unit, 60/- each, carriage 5/-. Ditto for D.C. mains, 45/- each, carriage 5/-. (all 20 amp. load). **SWITCHBOARD METERS.** 4in. scale Moving coil (D.C.) only, 0 to 14 amps., 17/6 each, post 1/6. Ditto, A.C./D.C., 22/6 each, post 1/6. Another 0 to 30 amps., A.C./D.C., 25/-, post 1/6. **MAINS TRANSFORMERS** (new). Input 200-250 volts in steps of 10 volts, output 350-0-350 volts 180 m/amps., 4 volts 4 amps., 5 volts 3 amps., 6.3 volts 4 amps., 39/6 each, post 1/6. Another 350-0-350 volts 180 m/amps., 6.3 volts 8 amps., 0-4-5 volts 4 amps., 39/6 each, post 1/6. Another 500-0-500 volts 150 m/a., 4 volts 4 amps. C.T., 6.3 volts 4 amps., C.T., 5 volts 3 amps., 42/6 each, post 1/6. Another 425-0-425 volts 160 m/amps., 6.3 volts 4 amps., C.T. twice, 5 v. 3 amps., 42/6 each, post 1/6. **DOUBLE WOUND VOLTAGE CHANGER TRANSFORMERS** 3,000 watts, 110 to 240 volts or vice versa, weight 100 lb., £10/10/- each, carriage 10/-. **BOOSTER TRANSFORMER.** Auto-wound tapped 0-6-10-19-175-200-225-250 volts 1,500 watts, £3/5/- each, carriage 5/-. **EX.W.D. SURPLUS METERS.** 2in. scale 0 to 20 volts, 6/6 each, post 6d.; 0 to 40 volts, 7/6 each, post 6d. (both moving coil). Thermo coupled, 0 to 350 m/amp., 7/6 each, post 6d. **SWITCHBOARD.** 4in. scale Amp. meters, moving coil meters, 100 to 250 amps., complete with shunt, 30/- each, post 1/6. **EX-RADAR MAINS TRANSFORMERS.** 230 volts, input 50 cycles, 1 phase. Output 4,500-5,500 volts approx., 30 m/amps., 6.3 volts 2 amps., 4 volts 1½ amps., 2 volts 2 amps.; these transformers are new, immersed in oil. Can be taken out of the oil and used as television transformers, giving an output of 10 m/amps.; overall size of transformers, separately, 5½ × 4½ × 4in. and 3 × 3 × 2½in., price £3/10/- each, carriage paid. **ELECTRIC MOTORS, FAN TYPE.** 110 volts D.C., 7/6 each, post 1/6. **RELAYS,** small type, 1,200 ohm coils, platinum points, 2 M. and B., 8/6 each. **ROTARY CONVERTORS.** 24-28 volts D.C. input, 1,200 volts 70 m/amps. D.C. Output 10/- each, P.F. **AUTO WOUND VOLTAGE CHANGER TRANSFORMERS.** Tapped 0-110-200-230 volts 350 watts, 48/6 each, post 1/6. As above but 500 watts, 62/6 each, carriage 3/6. As above 200 watts, 35/- each, post 1/6. 1,600 watts, tapped 0-110-150-190-230 volts, £5/5/- each, carriage 5/-. **DU-COIN VARIABLE TARIFF 1/- — 1d. SLOT METERS.** 200-250 volts A.C., 50 cycles, 1 phase, 5 amp. load. Tariff can be varied from ½d. to 1/3 per unit. Data sheet supplied, 45/- each, carriage 3/6. **EX-RADAR TYPE 101 R.F. UNITS** (new). Containing 6 valves, including grounded grid triode F.H.P., 24 volt universal motor, numerous resistances and condensers, etc., 35/- each, carriage 3/6. **RECTIFIERS** (new). D.C. output 36 volts at 50 amps., complete with mains transformer, 230 volts A.C. Input 50 cycles, 1 phase. Output to match the required voltage for the rectifier, £15 per set, carriage 10/-. **MAINS TRANSFORMERS** (new). Suitable for spot welding, input 200-250 volts, in steps of 10 volts. Output suitably tapped for a combination of either 2-4-6-8-10 or 12 volts at 50-70 amps., 87/6 each, carriage 7/6. **EX-NAVAL ROTARY CONVERTORS.** Input 110 volts D.C. Output 230 volts A.C., 50 cycles 1 phase, 800 watts, capable of 50 per cent. overload as new, crated weight 2½ cwt., price £25 each, carriage forward. Another ex-naval type 110 volts D.C., input. Output 230 volts A.C., 50 cycles, 1 phase, 250 watts, capable of 50% overload, weight 100 lb., price £10/10/- each, carriage forward. **ELECTRIC LIGHT QUARTERLY TYPE CHECK METERS.** All for 200-250 volts A.C., 50 cycles, 1 phase, 5 amp. load, 17/6 each, post 1/6; 10 amp., 21/- each, post 1/6; 20 amp. load, 25/- each, post 1/6. **SLIDER VARIABLE RESISTANCES.** 14 ohms, 1 to 4 amps., 12/6 each, post 1/-. Another 0.4 ohms, 25 amps., 10/- each, post 1/6. **MAINS TRANSFORMERS** (new). 200-250 volts input, in steps of 10 volts. Output 0, 6, 12, 24 volts 6 amps., 37/6 each, post 1/6. Another as above, but 10-12 amps., 49/6 each, post 1/6. Another, as above, but 25-30 amps., 79/- each, carriage 3/6. Another input as above, output 0, 18, 30, 36 volts 6 amps., 42/6 each, post 1/6. **FIRST GRADE MOVING COIL METERS** (switchboard). 6in. scale, 0 to 10 volts, 25/- each, post 1/6; 0 to 75 volts, 27/6 each, post 1/6; 0 to 200 volts, 27/6 each, post 1/6. **FERRANTI AUTOMATIC VOLTAGE REGULATOR TRANSFORMERS.** Input 180/265 volts 50 cycles 1 phase. Output 140/240 volts at 1.44 kilowatts, £32. Another, as above, but 3 kilowatts, £17/10/-. Another as above, but 4.5 kilowatts, £45, carriage forward.

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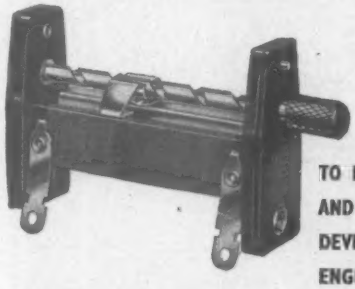

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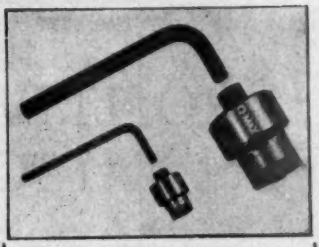

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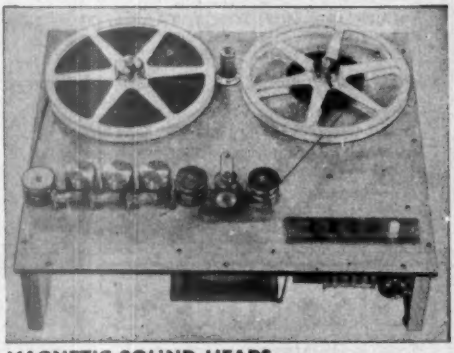

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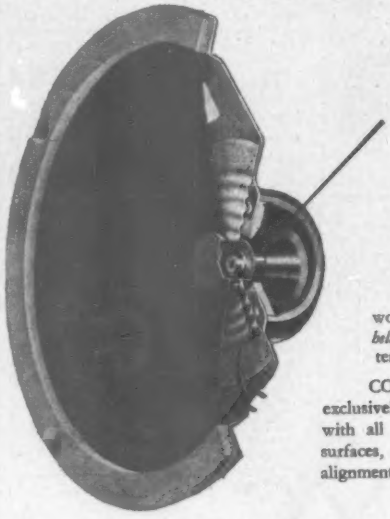

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FU12. Output 0-4-6.3 v. 3 amps. 19/6
FU24. Output 0-12-24 v. 1 amp. 19/6
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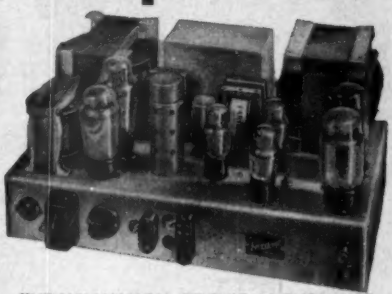

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★ **Impregnated grid coupling condensers.**
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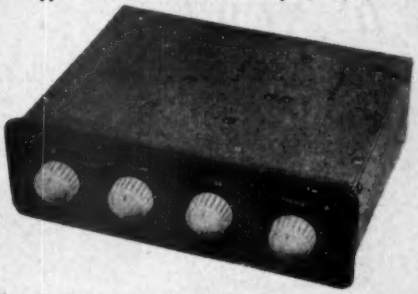

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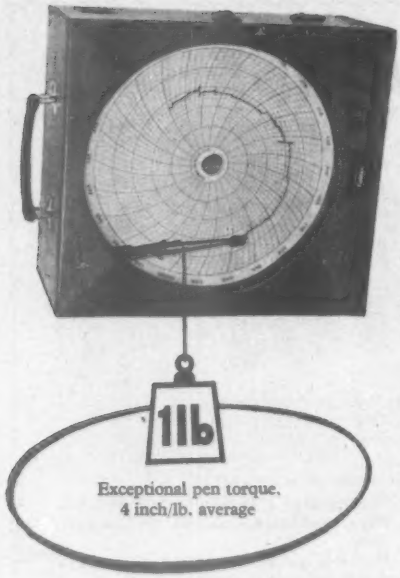

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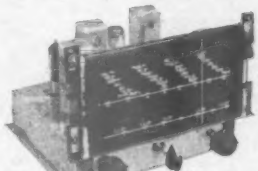

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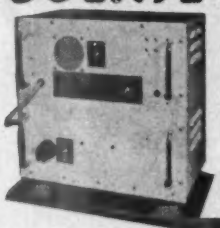

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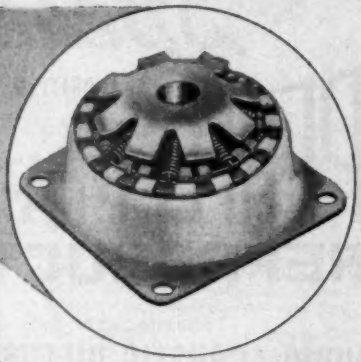

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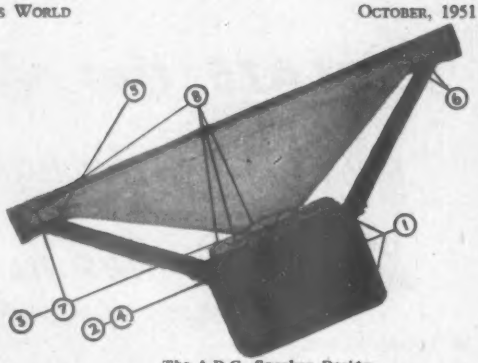

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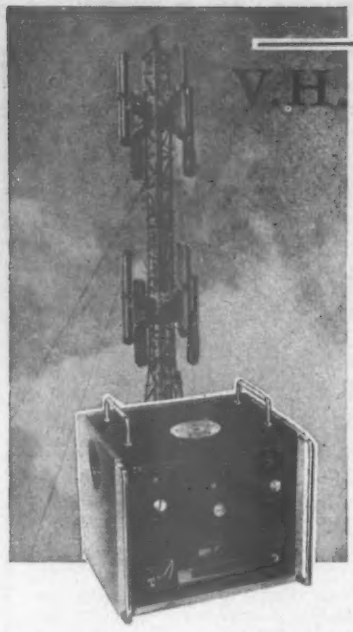

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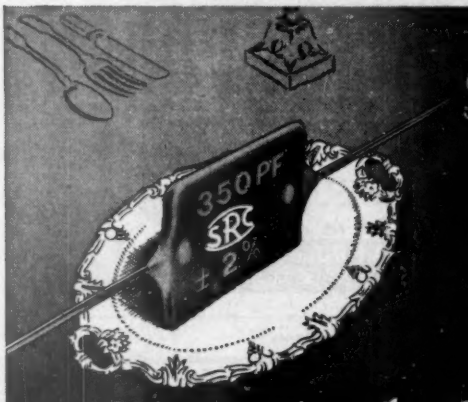

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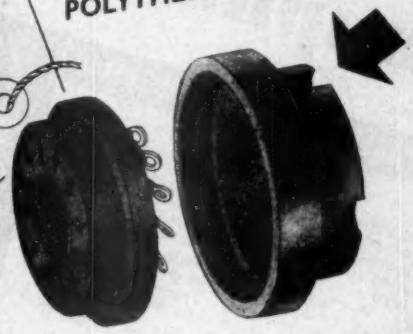

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41st YEAR OF PUBLICATION

Managing Editor: HUGH S. POCOCK, M.I.E.E.
Editor: H. F. SMITH

OCTOBER 1951

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This implies a high amplification, low noise and cross-modulation, and ability to handle signals of a wide range of amplitude.

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It is important that the oscillator grid current should be maintained as close to the target value as possible. In a frequency changer, a low value of oscillator current results in increased noise and loss of gain, while excessive oscillator current may cause spurious responses due to harmonics, and may also produce squegging at the high frequency end of the short-wave bands.

The ECH42 and UCH42 can be used without difficulty at frequencies up to 30 Mc/s in receivers having an I.F. of about 465 Kc/s and upward. Their performance will be very good at these frequencies if the coupling between the oscillator circuit and the input circuit is neutralised. This can be easily arranged by suitable layout of the circuit.

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Type ECH42 for A.C. Mains and Car Radio Sets

Type UCH42 for D.C./A.C. Mains Sets

	ECH42	UCH42	
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V_h	6.3	14.0	V
I_h	0.23	0.1	A
Characteristics			
Hexode Section			
V_a	250	170	V
V_{g2+g4}	85	70	V
R_{g3+gt}	47	47	KΩ
I_{g3+gt}	200	200	μA
V_{g1}	−2.0	−1.85	V
I_a	3.0	2.1	mA
I_{g2+g4}	3.0	2.6	mA
g_c	750	670	μA/V
r_a	> 1.0	> 1.0	MΩ
R_{eq}	75	65	KΩ
Triode Section			
V_{at}	100	100	
V_{gt}	0	0	V
I_{at}	10	10	mA
g_m	2.8	2.8	mA/V
μ	22	22	
Limiting Values			
Hexode Section			
$V_{a\,(b)}$ max.	550	550	V
V_a max.	250	250	V
p_a max.	1.5	1.5	W
$V_{g2+g4\,(b)}$ max.	550	550	V
V_{g2+g4} max. (I_a=3mA)	125	125	V
V_{g2+g4} max. (I_a<1mA)	250	250	V
p_{g2+g4} max.	0.3	0.3	W
I_k max.	7	7	mA
V_{h-k} max.	50	150	V
Triode Section			
$V_{at\,(b)}$ max.	550	550	V
V_{at} max.	175	175	V
p_{at} max.	0.8	0.8	W
I_k max.	6	6	mA

THE COMPLETE SERIES

	FREQUENCY CHANGER	R.F. OR I.F. AMPLIFIER	DET. A.F. AMPLIFR. & A.V.C. DIODE	OUTPUT PENTODES	RECTIFIERS
6.3 V Heater	ECH42	EF41	EBC41	EL41; EL42	EZ40; EZ41
0.1 A Heater	UCH42	UF41	UBC41	UL41	UY41

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MVM176

Wireless World

OCTOBER 1951 VOL. LVII. No. 10.

Domestic Radio on Show

THE British radio industry is nothing if not resilient. Early in the year it suffered the shock of doubled purchase tax on domestic sound and vision receivers and valves. Besides, it has been labouring for some time under a feeling of uncertainty as to its commitments for the national defence programme. Then there have been threatened or actual shortages of essential materials. Taking all these things into account, it might well have been expected that manufacturing programmes, as made evident at the recent Radio Exhibition in London, would have shown distinct signs of austerity and a marked tendency towards the cautious *status quo*.

As is shown in our review of the exhibition, printed elsewhere in this issue, the contrary is the case, and a distinctly healthy state of affairs is revealed, at any rate in regard to television. In this branch of the art and in domestic sound receivers the exhibition may fairly be said to have been representative, though no other branches are fully covered.

In television the absence of austerity was particularly noticeable, and a rather unexpected trend towards bigger pictures was clearly evident. Last year we recorded the tendency towards standardizing the 12-in tube for direct-viewing sets: that practice is now well established, but, surprisingly, we have many sets with still larger tubes of 15in and 16in, while the 9-in type has almost disappeared. There was even a 21-in model, though this is by way of being a novelty at present.

So far, the question of metal *versus* glass for cathode-ray tube cones has not developed into an open battle, and, broadly speaking, the use of metal has been restricted to the larger tubes. No doubt the scarcity of the particular type of steel alloy used for this purpose has imposed rather artificial and perhaps temporary restrictions.

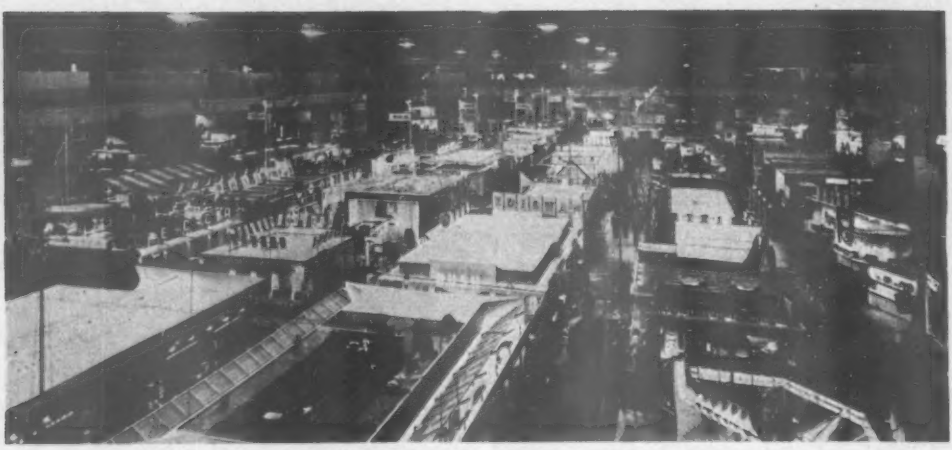
Although dogmatism would be unjustified, it is fair enough to say that the amount of effort put into the development of larger and still larger tubes suggests great confidence in direct viewing as opposed to projection systems, for which there seems to be, among the majority of designers, rather less enthusiasm than last year.

In sound receivers there is a much greater tendency towards standardization in technical features, and much less to record in the way of trend of design. The comparatively few novelties introduced are in the nature of the single swallow that proverbially does not make a summer. Perhaps, however, the "valveless" crystal-triode set shown as a non-commercial novelty this year may point the way to future trends. Though crystal-triodes are not yet ordinary articles of commerce, it is a fact that crystal diodes and contact rectifiers generally are coming into wider use in conjunction with thermionic valves, both in sound and television receivers.

Unkind things are often said about the mechanical design of radio equipment, but these reproaches are becoming rather out-dated. The principal advance noted this year in the way of mechanical design is the provision of better accessibility, particularly for maintenance, and this subject is treated at length on another page.

It is pleasing to record a tendency to group valves for domestic receivers into something approaching "preferred" ranges. These, while meeting the needs of most designers (and simplifying their tasks) help to restrict the number of different types in use.

Although, as we have already said, the exhibition was fully representative only in the field of domestic equipment, there was at least enough in some other spheres to attract the visitor with other interests. In this connection we must not forget the highly successful Convention on Audio Engineering, organized by the British Institution of Radio Engineers. The convention was held in the exhibition building, and proved to be a valued extra attraction to many visitors with specialized interests. A selection of some of the topics discussed is dealt with elsewhere in this issue. *Wireless World* believes that the holding of conventions, meetings, lectures and demonstrations in conjunction with the annual exhibition would do much to enhance its prestige and value.



Radio Exhibition Review

Trends in Domestic Receiver Design—and Some Highlights

In the following pages the technical Staff of *Wireless World* report on tendencies in design as exemplified at the 18th National Radio Exhibition

TELEVISION

AN obvious trend in television receivers, which even the least observant visitors to the Exhibition cannot have failed to notice, is towards larger pictures. Last year 12-in tubes were in the majority, but with the 9-in still very well represented. This year 15-in and 16-in tubes are roughly as common as the 12-in and the 9-in is plainly disappearing; there was even one set with a 21-in tube! This trend is perhaps most plainly shown by the fact that a 15-in tube no longer looks large, while a 9-in definitely seems very small.

In the cabinet work the favourite material is wood, for both table and console models. Plastic cases are still used by some firms and Sobell have even a console model of this type, but they are comparatively rare. The "safety glass" is commonly a plastic, moulded to the tube contour and very frequently it is tinted. Such tinted screens permit better contrast to be secured for daylight viewing, provided always that the picture itself is bright enough to stand the transmission loss of the screen. At least three different densities of screen are used. Of some 29 firms exhibiting direct-viewing receivers, some 13 had models with tinted screens and the rest had clear screens. There is, therefore, no general trend one way or the other and the choice is a matter of personal preference; some makers have models of both types.

The picture shape is still usually rectangular, but a few models are designed with the so-called "double-D" picture. In this the sides of the picture are curved and the top and bottom straight; the picture width is made equal to the diameter of the tube. An effectively bigger picture is thus secured, but the corners are lost. As there is commonly little of interest in the corners, this loss is not very important.

The transformerless technique which has been developed in the last few years is obviously here to stay. A very common practice is to use an auto-transformer which is tapped for the mains-voltage adjustment and which enables a supply of 250V to be obtained from all mains. The h.t. supply is taken directly from this through a half-wave rectifier and the valve heaters are series-connected in groups and fed from a tapping. The ratios involved in the auto-transformer thus do not depart very widely from unity and so the component is much smaller, lighter and cheaper than a double-wound transformer. Its stray field is also much smaller. The disadvantage that there is no isolation from the mains is not an important one in commercial practice, because the cabinet provides the necessary insulation.

Some sets do not have the auto-transformer and these are suitable for d.c. operation as well as a.c. Since no step-up of voltage can be obtained on d.c. supplies, they must obviously be designed for the lowest voltage supplies and a dropping resistor used for higher voltages. This increases the heat dissipation and makes the design more difficult.

The e.h.t. supply for the tube is nearly always derived from the line fly-back[1] and the voltage used is

[1] "Flyback E.H.T.," by W. T. Cocking, *Wireless World*, August and September 1950

considerably greater than a few years ago. The use of 7-10 kV is now common in 9-in and 12-in models and up to 14 kV in the 16-in. This has resulted in a marked increase of picture brightness; in fact, in many cases the picture can be made too bright. Above a certain level flicker becomes evident and this point can be reached in many of the new sets—even in the 16-in tube ones. In order to improve the regulation of the fly-back e.h.t. supplies, some makers fit a Metrosil resistor across their output. This has a resistance which depends markedly on the applied voltage and so a rise of voltage results in a lowering of resistance and an increase in the current drawn from the supply, with the result that the rise of voltage is less than it would be without the stabilizer. One example of this method is the Ekco T164—a table model with a 16-in tube.

Economy scanning circuits are widely used. Their use is essential with some of the new "short" tubes, which are better named "wide-angle" types. In these the pentode used for the line scan is arranged to be operative for about two-thirds of the scan only and the initial third is provided by a diode controlling the release of the energy stored in the deflector coil at the end of the fly-back. This energy is utilized to charge a capacitor which is connected in series with the h.t. supply—the system being commonly known as h.t. boost. Without it, the transformerless set would be almost impossible. The system depends on the use of low-loss materials for the scanning components and for this reason Ferroxcube has largely displaced laminations for the line-scan transformer.

One of the greatest practical difficulties with such circuits is in securing a linear scan and there are two different methods in use. The first is usually attributed to Schade[2] and in one form is exemplified by the circuit of Fig. 1 which is the scanning circuit of the Bush TUG26—a 16-in model. In this, V_1 is the line-scan output pentode which feeds the e.h.t. rectifier V_2 through the usual auto-transformer. The economy diode is V_3 and, since its cathode is connected to a point of high peak pulse voltage, the heater-cathode potential is kept low by feeding its heater through a bifilar winding on the auto-transformer. Picture width is controlled by varying the tapping point of the deflector coils on the auto-transformer by the switch S and the choke L_1 enables the effective inductance loading to be kept roughly constant. The main linearity circuit is LC; the pentode current flows through a part of it and develops a voltage to control the diode. For a more detailed description of the characteristics of circuits of this type the reader is referred to recent article in *Wireless World*.[3]

An alternative method of linearity control is to insert a saturated reactor in series with the deflector coil. The scheme used by Ekco is shown in Fig. 2. Here L_1 is the saturated reactor. In this case the coil is wound on an open Ferroxcube core which is saturated to the requisite degree by a permanent magnet. An adjustment is provided as a linearity control. The back-e.m.f. developed across it falls as the current increases and so acts to control the current in the

[2] "Magnetic Deflection Circuits," by Otto H. Schade, *R.C.A. Review*, September 1947.

[3] "Efficiency Line-Scan Circuits," by W. T. Cocking, *Wireless World*, August, September and October 1951.

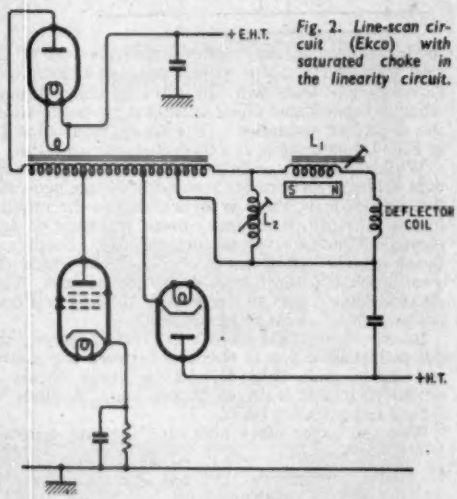


Fig. 2. Line-scan circuit (Ekco) with saturated choke in the linearity circuit.

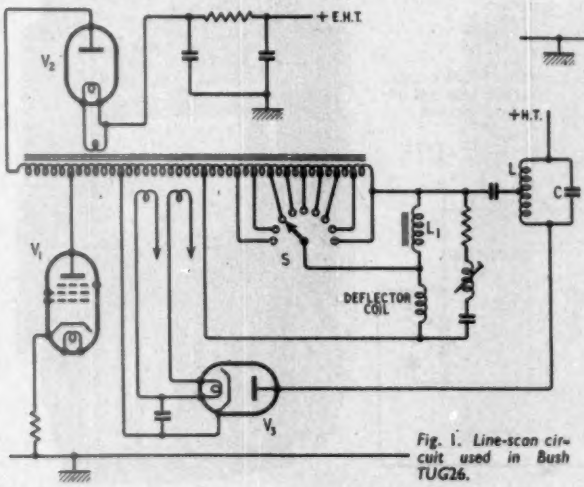
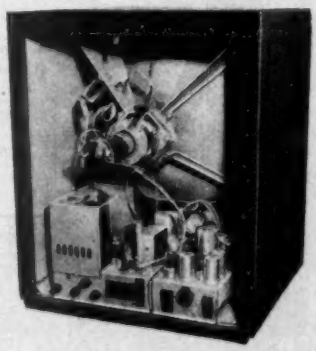


Fig. 1. Line-scan circuit used in Bush TUG26.



Ekco T164 receiver with 16-in tube.

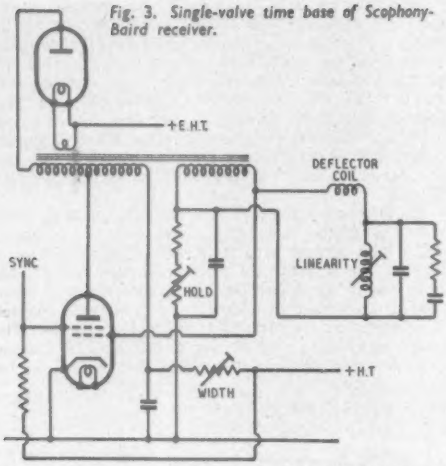


Fig. 3. Single-valve time base of Scophony-Baird receiver.

diode, tending to cut it off towards the end of the scan. Instead of the permanent magnet, a closed core is sometimes used with an extra winding through which a controllable direct current is passed to adjust the degree of saturation. The shunt inductance L_2, in Fig. 2, is adjustable as a control of picture width.

While most sets probably still use an output pentode driven by a separate saw-tooth voltage generator for the line-scan, there is an increase in the number in which a self-oscillating current generator is employed. There are several forms of this. Scophony-Baird use the arrangement of Fig. 3, in which the transformer is coupled back to the control grid. This electrode also acts as an "economy" diode, but it does not permit h.t. boost to be obtained.

In the case of the G.E.C. BT5145, however, the self-oscillating action is obtained between the control and screen grids (Fig. 4) and the anode circuit is similar to that of a driven output stage. A diode V_3 is used and gives h.t. boost.

With the larger tubes now used the line structure of the picture naturally becomes more prominent unless the viewing distance is proportionally increased. To counter this the Ekco TC165 is fitted with spot wobble.[4] A small extra pair of deflector coils is fitted between the focus magnet and the normal deflector coils and is fed from a 11.5-Mc/s oscillator to provide a small vertical deflection at high frequency. There is an amplitude adjustment at the rear and a switch is provided to cut out spot wobble. This is almost a necessity since the focus adjustment is much more difficult if the lines cannot be seen.

Frame time-base design is much more conventional and nearly always there is a saw-tooth voltage generator followed by a pentode transformer coupled to the deflector coils. An exception is English Electric, who use a high-inductance deflector coil resistance-capacitance fed. The voltage generator is quite often a blocking oscillator, but some makers prefer to use two valves working as a multivibrator. For example, Baird use a cathode-coupled multivibrator, whereas Philco employ earthed-cathode valves connected in the original Abrahams-Bloch form.

Compensation for the finite reactance of the output coupling circuit is always needed, and there are two main forms in general use. One, due to Blumlein,[5] depends on negative feedback through both differenting and integrating forms of circuit. The other depends on pre-distorting the input to the output valve by passing it through an RC-network which has the effect of adding a more or less linear saw-tooth wave to its integral.[6] Neither circuit is new; both are well-known and have been used for years and one cannot say that there is any definite trend towards a preference for either.

Turning now to the signal side, there is a marked tendency towards the superheterodyne in preference to the straight set. This is unquestionably due to the

[4] "Television Spot Wobble," by R. W. Hallows, *Wireless World*, March 1950. "More About Spot Wobble," by T. C. Nuttall, *Wireless World*, May 1950.

[5] "Time Bases," by O. S. Puckle, p. 137 (2nd Edition). Chapman & Hall.

[6] Puckle, *loc. cit.*, pp. 117-123.

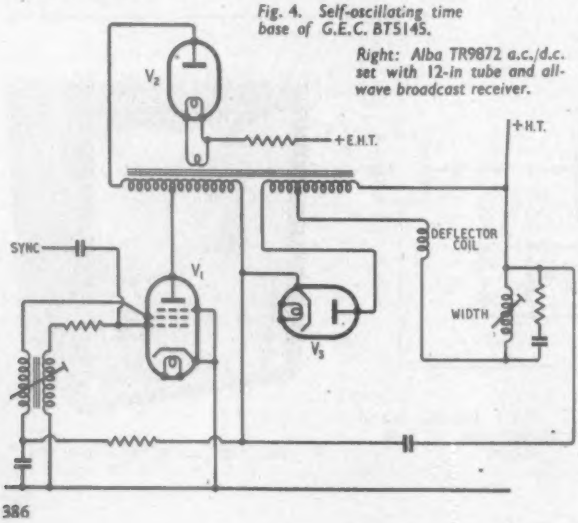


Fig. 4. Self-oscillating time base of G.E.C. BT5145.

Right: Alba TR9872 a.c./d.c. set with 12-in tube and all-wave broadcast receiver.

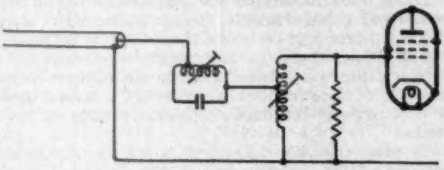
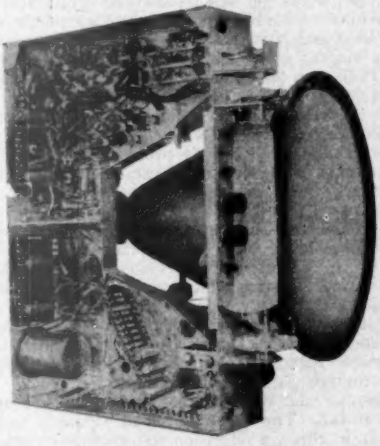


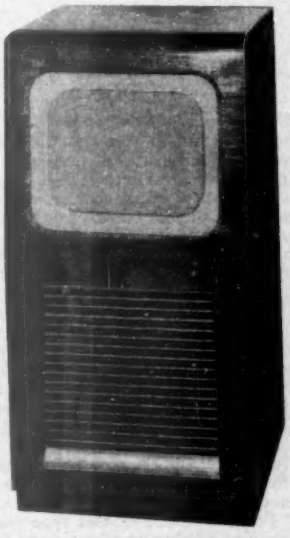
Fig. 5. I.F. input rejector used in Invicta T112.

H.M.V. model 1820 with 21-in tube.



Underview of chassis of English Electric receiver.

Pilot TM54 table model receiver with switch channel selection.



Ferguson console with 16-in tube.

Plug-in coils for channel selection in Philips television receiver.

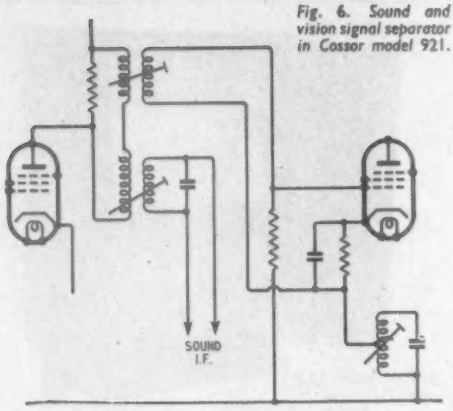


Fig. 6. Sound and vision signal separator in Cossor model 921.

need for catering for five television channels. There is also a definite trend towards the use of higher intermediate frequencies and a figure of some 34.5 Mc/s bids fair to become standard. This high frequency has been chosen largely because it permits much greater freedom from the special superheterodyne interference problems. It is probably the only frequency which gives such freedom on all five television channels. The factors involved were dealt with in *Wireless World* some time ago.[1]

Because the frequency is nearer the signal frequency, however, there is a greater risk of interference from signals on the intermediate frequency and, to counter this, sets with the 34.5-Mc/s frequency often include an input trap circuit. The Invicta T112 is an example and has an input wavetrap tuned to 36 Mc/s (Fig. 5).

The usual practice is to have one r.f. stage at signal frequency and a frequency changer which is quite often of the single-valve type. Some sets have three signal circuits, but two only is a common number. These early circuits are common to both sound and vision channels and the split takes place after the mixer. One method of doing this is shown in Fig. 6; this is used in the Cossor 921 and the sound-channel rejector takes the form of a cathode trap in the first vision-channel i.f. stage

The method of catering for reception of any of the five television channels varies very much from one set to another. Quite a number provide continuous tuning by fitting the signal- and oscillator-frequency coils with dust-iron cores and designing them to give the requisite coverage. In some cases (Ekco), the adjustment is made in the factory; in others, (Bush), they are arranged as a user adjustment.

This continuous coverage is by no means universal, however, and several other schemes are in use. Pye and Invicta have tapped coils so that the dealer can make a change of channel by altering certain connections. Philips adopt plug-in coils; the coils are pre-set in the factory and one set can be plugged-in in the place of another without adjustment. Other firms make signal and oscillator circuits with their valves as a complete sub-unit which can be replaced if a different channel is needed. This scheme is used by Murphy and G.E.C. and is almost invariably the one adopted when the straight set is retained.

[1] "Television Station Selection," by W. T. Cocking, *Wireless World*, July 1949.

Diode noise limiters are now standard fittings on both sound and vision channels. On the sound side a series diode is usual, but on vision there is more variety. A biased diode across the tube input is common but a similar diode is sometimes fitted to the detector output instead. A third variety is the use of a biased diode to give negative feedback on the video stage on noise peaks.

In most sets, the v.f. signal is fed directly to the cathode of the c.r. tube but in the English Electric model an a.c. coupling is used with a black-level clamp. This is not the same as the usual d.c. restorer circuit, which works on the sync-pulse amplitude, for it operates on the black level of the back porch. A diode is used and is switched by a sine wave derived from the ringing choke e.h.t. circuit.

Projection television sets based on the Mullard tube operating at 25 kV and using the Schmidt optical system were well in evidence last year. This year they take substantially the same form. The different models are all similar so far as the projection part is concerned but differ in their circuitry, cabinet styles and viewing screens. Models were shown by Philips, Decca, Dynatron, Peto-Scott, R.G.D., Etronic and Valradio. This last firm had a model designed for a power supply as low as 50-V direct current.

As an example of television technique Mullard exhibited a system which could reproduce on a television screen anything written on a glass screen. A sheet of glass was scanned by a projection tube operating at 25 kV and using the Schmidt optical system. Anything placed on the screen,—writing, a photograph, etc.,—reflects light according to its character and this reflected light is picked-up by a photo-cell. The resulting video signal is amplified. It is, in effect, a television transmission system using a flying-spot scanner. Although shown in the form of a novelty it has obvious application to radar, where it can be used to superpose a map or written information on a plan-position indicator.

BROADCAST RECEIVERS

ALTHOUGH television may be said to have "stolen the Show" the sound broadcast receiver is still the focal point in the majority of homes, and the industry offers a sufficient variety of four-valve superheterodynes in polished veneer cabinets to sustain the pre-war atmosphere of the stands. For the most part these follow strict economy in circuit design and provide a performance which is adequate under present medium-wave conditions, but here and there a welcome break from convention is to be noted. In the Ace Radio "Selector" chassis, for instance, the usual 532-pF tuning condenser is replaced by one of 187 pF maximum in each section, giving a more favourable L/C ratio in the tuned circuits and some measure of bandspread tuning. There are two medium-wave ranges, 130-275 metres and 270-570 metres; the long waves cover 1,000-2,000 metres and there is a short-wave range of 16-33 metres.

Quite a few table models now incorporate frame aerials for flat dwellers and others who may find it inconvenient to take advantage of an outdoor aerial. The Ekco "Festival" set is of this type and is also notable for the fact that switched tuning of four fixed stations takes the place of the normal continuous tuning scale. In the Ferranti Model 215 the frame

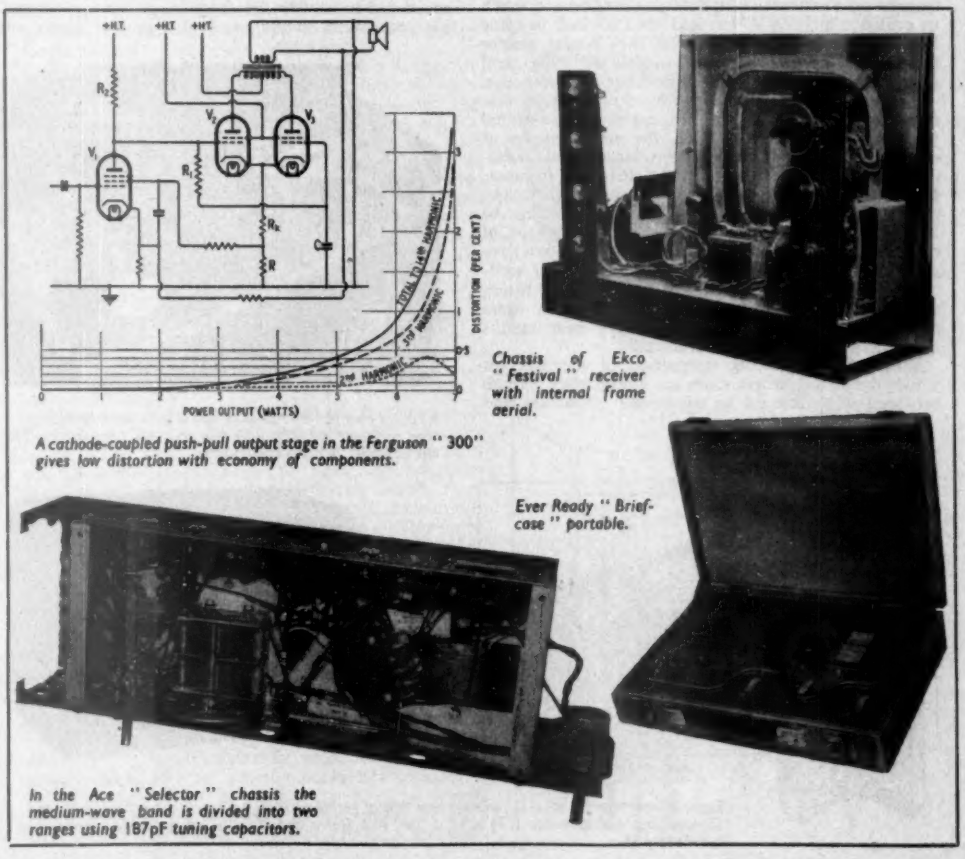
aerials are switched out of circuit and separate input tuning coils used with an external aerial.

In general the export versions of most manufacturers' sets contained the refinements, which, before the days of purchase tax, would have been available at a price attractive to the home market. The 9-valve circuit of the Murphy 160, for instance, has been designed primarily for optimum short-wave efficiency and incorporates 10 wavebands selected by push-button, eight with bandspread tuning. Maximum gain is derived from the push-pull output stage on short waves, but negative feedback is introduced on the medium-wave range. Several H.M.V. export models (e.g., Models 5312 and 5411) employ an earthed-grid triode as r.f. amplifier on the short-wave ranges. The Marconiphone T28 series also adopts this form of r.f. amplification and the T28BT is designed for operation from a 6-volt accumulator; press-button illumination of the tuning scale is provided in the interest of battery economy. Six-volt operation is also a feature of some Bush export receivers and of the Invicta Model 94 export model.

Increasing public interest in the possibility of higher quality of reproduction is reflected in the return to push-pull output stages in moderately priced consoles and radio-gramophones as well as in the luxury class. Typical of this trend are the Bush SUG26 and the McMichael 551AC.

One of the most interesting push-pull circuits technically is that used in the new Ferguson "300" radio-gramophone. Phase reversal is effected in the output stage itself which is cathode coupled*. The grid of V_3 in the accompanying diagram is tied down to earth so far as a.f. voltages are concerned by the capacitor C, but the grid potential relative to the cathode varies in accordance with the fluctuations of current in R and R_k, and is 180 degrees out of phase with the input applied to the grid of V_2. The amplitudes of the a.c. components of the cathode currents in each valve, which are in opposition, are not quite equal and the difference provides the drive for V_3. The resistance R_1 is necessary only for bias purposes. One disadvantage of the cathode-coupled circuit is that it is not self-compensating as far as fluctuations of h.t. supply are concerned, but this has been overcome in the Ferguson amplifier by deriving the screen voltage of V_1 from the common cathode circuit of V_2 and V_3. As far as d.c. is concerned these valves are in parallel, and with this arrangement

* See, for example, S. W. Amos, *Wireless Engineer*, February 1946, p. 43.



A cathode-coupled push-pull output stage in the Ferguson "300" gives low distortion with economy of components.

Chassis of Ekco "Festival" receiver with internal frame aerial.

Ever Ready "Briefcase" portable.

In the Ace "Selector" chassis the medium-wave band is divided into two ranges using 187pF tuning capacitors.

there is effectively negative d.c. feedback. The anode load R_2 of V_1 is of high value and gives the high internal gain desirable with overall negative feedback; it also gives a steady anode potential which differs from the cathode potential of the following stage by the amount required to bias the output valves. Direct connection to the grid of V_2 is then possible, and with the elimination of the usual RC coupling, much more feedback (actually 30db) can be applied from the output transformer secondary to the cathode of V_1 without low-frequency instability.

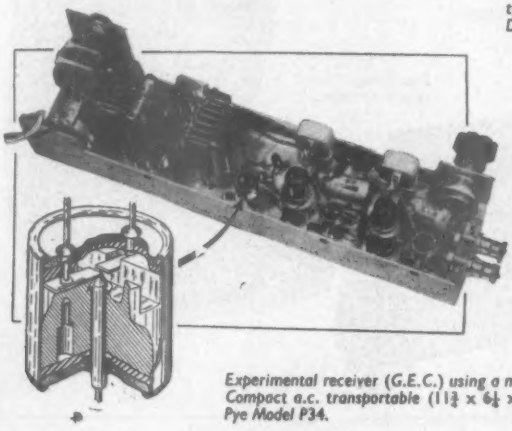
No fundamentally new acoustic methods for obtaining better quality were observed, though the many known alternatives all had their devotees. Murphy showed several modifications of their "baffle" type sets which are designed to present a large surface with the minimum of enclosed air. Avoiding the difficult intermediate types of cabinet, Dynatron go to the other extreme by totally enclosing the back of the loudspeaker to suppress out-of-phase radiation—the so-called "infinite baffle." They use a 4-cu ft chamber to reduce the stiffness due to the enclosed body of air and give it an irregular shape to prevent internal standing waves. A special loudspeaker unit with a fundamental resonance as low as 29 c/s has been developed to offset the rise in frequency on enclosure. Elliptical diaphragms are much in evidence in H.M.V. sets and are also used in some K.B. models. It is claimed that they confer greater freedom in cabinet design than circular types and give a better distribution of high-frequency response.

Recent advances in the quality of commercial disc recordings both at 78 and 33⅓ r.p.m. have resulted in complementary changes in the specifications of current high-grade record reproducers and radiogramophones. The H.M.V. Model 1614, for instance, which uses the latest gimbal-mounted lightweight pickup has an input filter circuit which can be switched at will to give a 20 per cent extension of the high-frequency range on the latest (and new) records, above what can be tolerated on early or well-worn records. Both Decca and Dynatron are fitting transcription-type playback turntables in their more expensive models to ensure the very best results from 33⅓-r.p.m. microgroove records.

What of the growing proportion of listeners for whom the sound programmes are a secondary though very necessary interest to television? Neatness and portability are predominant features of the sets which are encouraging them to replace the old table models ousted from pride of place by the television receiver. The demand at the moment seems fairly equally divided between mains/battery receivers, which are suitable for long periods of use in the home as well as for occasional use further afield, and "all-dry" battery portables, which achieve the acme of lightness and compactness in the so-called "personal" sets. The price paid for extreme compactness is limited battery endurance, and the tendency now is towards the slim attaché case form, which, although bigger, is in many ways more convenient to handle. The new Ever Ready "Briefcase" portable is typical of this trend and has a duration of 300 hours with a B107 "Batrymax" layer type h.t. battery and 110-120 hours from the No. 14 l.t. cell.

The decision of G.E.C. to show their experimental crystal triode receiver at the Show serves as an indication of possible future trends. Successful reception of B.B.C. programmes was demonstrated in London just prior to the Show on a receiver consisting of four r.f. stages, the equivalent of an anode bend detector and a push-pull output stage delivering 100 mW to a loudspeaker. Current consumption was 10 mA from a 70-V battery. G.E.C. Research Laboratories have succeeded in solving the chemical problem of extracting germanium in the required degree of purity and

A record changer for 78 r.p.m. and a separate transcription-type turntable for 33⅓ r.p.m. records are provided in the Decca Model 96 radio-gramophone.



Experimental receiver (G.E.C.) using a new type of germanium crystal triode throughout, and right : Compact a.c. transportable (11¾ x 6½ x 9in) with frame aerials built into a plastic cabinet—the Pye Model P34.

have developed a slotted spring form of contact which, in conjunction with a conical crystal, gives the necessary precision of spacing under manufacturing conditions. It is emphasized that it will be some time before germanium *triodes* are available on the same basis as the diodes and that even then they will probably replace valves in electronic computors, and possibly hearing aids, before they invade the field of radio receivers.

VALVES and CATHODE RAY TUBES

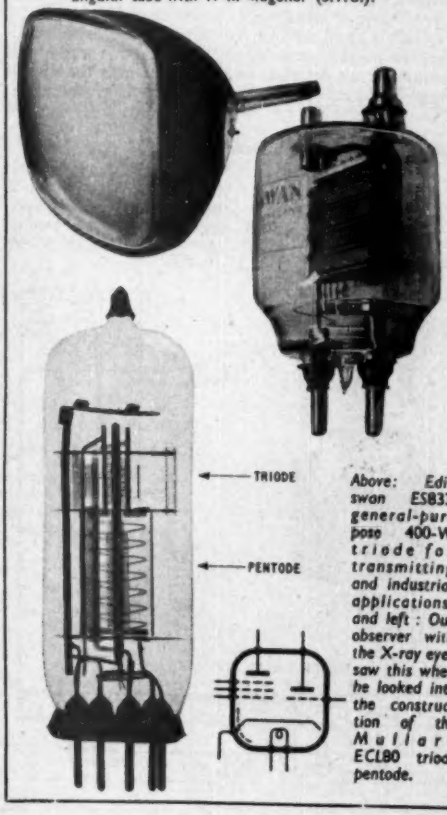
MINIATURIZATION of the receiving valve is now practically complete and the new size is becoming accepted as standard (once again!). Soon, the term "miniature" may be no more than an interesting archaism, unless of course it is kept on to describe what is now sub-miniature. Most of the new types are made in all-glass form, with the electrode support wires projecting straight through the base to form the connecting pins. Battery miniatures are almost exclusively on the B7G base, while mains types are divided between B7G, B8A and B9A (noval)—probably B9A will become standard in the end. The octal valve, standard a few years back, is beginning to look distinctly old-fashioned by comparison, although it is still in current use for the larger rectifiers and power output valves.

One can tell that the miniature situation has settled down, for a while anyway, by the existence of complete ranges of valves for specific equipments. For broadcast receivers, three firms are producing a 1.4-V battery range, a 6.3-V a.c. mains range and an 0.1A a.c./d.c. range for series-heater operation, all of which are recognizable by characteristic type numbers. Usually the same set of valves forms the basis of both the a.c. and the a.c./d.c ranges, the only difference being in the heaters. In addition, several makers are producing miniature ranges for television; these are mainly on the B9A base and have 0.3-A heaters designed for series operation in a.c./d.c. "transformerless" receivers. Mullard, for instance, were showing a preferred range known as the "World Series" which is designed to be acceptable for receiver design in any part of the world on any television standards.

Altogether there is nothing unusual in the characteristics of miniature valves compared with the older types. The fact that they do the same job in a smaller bottle is sufficient. At e.h.f. and television frequencies, however, they definitely show their superiority, for they have short, direct connections and no moulded base to cause losses. They have been criticized as not being reliable enough for use in communications equipment and it is certainly true that manufacturers are aiming at *greater* reliability. S.T.C., for example, were showing a range of "Trustworthy" miniature valves in which the electrode structure—where most failures occur—has been mechanically strengthened and improved; they cost about three times as much as ordinary miniatures, but at what a saving in other directions!

Another design trend in communications receiving valves is towards higher and higher frequencies. Miniature types are generally used, for the reasons stated above, and the spacing between electrodes is being made smaller to reduce the electron transit time. One method of doing this is to make the electrodes co-planar instead of concentric and the tech-

The 21-in Emiscope cathode-ray tube compared with a 1-in model, and below: Rectangular tube with 17-in diagonal (S.T.C.).



Above: Ediswan ES833 general-purpose 400-W triode for transmitting and industrial applications, and left: Our observer with the X-ray eyes saw this when he looked into the construction of the Mullard ECL80 triode pentode.

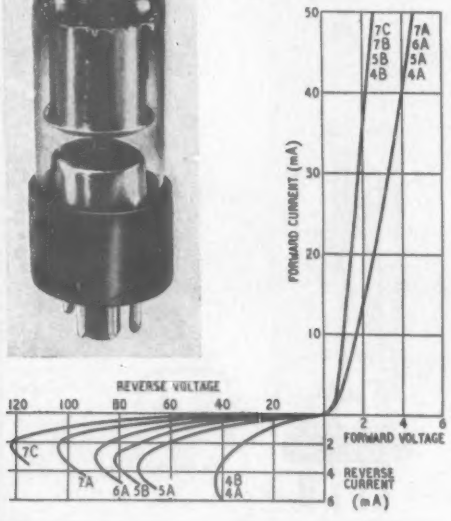
nique has now been extended from the disc-seal valves to valves with conventional connections: an example was shown on a miniature glass base.

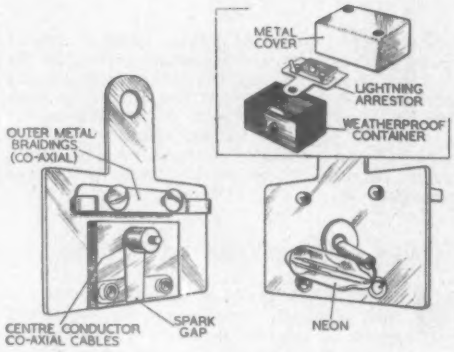
The germanium crystal has now firmly established itself as a useful rectifier and is replacing the thermionic diode in many circuit applications. Not only does it avoid the necessity for heaters but it has the advantages of small size, low self-capacitance, wide frequency range and almost unlimited life. Westinghouse have entered the field with a range identifiable by the letters WG. Much the same story applies to the ordinary metal rectifier, and this is especially noticeable in television receivers. Metal rectifiers are produced not only for the main h.t. supplies but as efficiency diodes and e.h.t. rectifiers; Westinghouse were showing a demonstration circuit giving nine positions where a thermionic diode had been replaced by either a metal rectifier or a germanium crystal.

While the 12-inch cathode-ray tube is still regarded unofficially as a kind of standard, there is a definite trend towards larger direct-viewing tubes in answer to the challenge from projection television. Hitherto, the 15-in tube has been the largest size made completely of glass, but now G.E.C. have come out with a 16-inch model. From this point the metal-cone tube seems to take over. Both English Electric and Mullard were showing their first efforts (16-in tubes) in this field, while H.M.V., in spite of a hint in this journal some twelve months ago, surprised everyone by producing a metal tube, made in the E.M.I. factory, with a 21-in screen. In all these, the metal cone forms the anode connection. Whether this trend will continue or not depends to some extent on the metal supply position. In America, shortage of metal is forcing manufacturers to drop magnetic focusing in favour of electrostatic focusing, although there is no sign of that happening here yet.

U41 high-voltage rectifier made by G.E.C.

Typical d.c. characteristics of the Westinghouse range of germanium rectifiers, WG4A to WG7C.





Aerialite television aerial lightning arrester.

With these larger tubes one is more aware of the wasted screen space (and extra room needed in the cabinet) that is inevitable with a rectangular picture on a circular screen. Corner-cutting helps but the problem is completely solved by the new tubes with rectangular screens; S.T.C. had one on show with a 17-in diagonal. One point, however, that is noticeable about all the big models is that the overall length has been kept down to something like that of the 12-in tube, while giving a larger picture, by increasing the deflection angle from the usual average of 50 deg to 70 deg.

Anode voltages vary from about 4kV to 17kV. The 9-inch tube goes up to about 8kV, the 12-inch to 10 kV the 16-inch to 14kV while the solitary 21-inch works at 17kV. Generally speaking the smaller sizes use octal bases and the larger ones duodecal. Metal-cone and rectangular tubes make possible flat screens as a matter of course, but some of the smaller tubes also have this feature now. To prevent ion burn, some makers fit ion traps (a magnet steers the electrons on to the right road and allows the heavier ions to blunder into a cul-de-sac) while others rely on aluminized screens. Ferranti consider a better way to avoid this trouble is by suitable processing of the tube beforehand. They do admit, however, that aluminizing brings advantages in brightness and contrast and the process is, in fact, very widely used in cathode-ray tubes now.

Development in transmitting valves is concerned mainly with reaching higher working frequencies and in industrial power valves with improving the safety factors for overload conditions. For industrial control purposes the cold-cathode valve is coming into prominence, while the xenon-filled thyratron is gradually replacing the mercury type.

TELEVISION ACCESSORIES

THE provision of a usable signal beyond the normal service range of a television station continues to be one of the principal problems facing designers of television aerials. No fundamentally new systems have appeared, but many variations of well-known types are being employed. Multi-rod arrays using

a number of parasitic elements remain the most popular and systems containing up to 8 elements are not uncommon.

One of the latest additions to this style is the Antiference X2D aerial consisting of two "Antex" or "X" aerials mounted side by side and spaced just under a half-wavelength apart.

A variation of an early type and of which little has been heard in recent years is the tilted-wire aerial supplied by E.M.I. It is a capacity-loaded system and is now available in a 20-foot size for erection in lofts and in small gardens. Hitherto the shortest length was not far off 50 ft.

Apart from this line of development the main changes in television aerials have been towards structural improvements, which, while not always visible to the eye, should make for greater robustness. As an example, Belling and Lee claim that their 4-element "Multirod" for fringe areas will withstand gusts of wind up to 80 m.p.h.

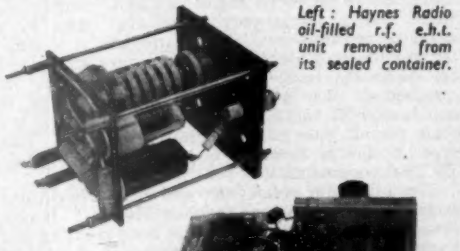
As reasonable safety precautions ought to be taken whenever an outdoor aerial of any kind is used, the introduction by Aerialite of a neat and well-designed lightning arrester is of more than usual interest. It is intended to be inserted in the co-axial feeder at a point convenient for a good earth connection and it contains a small neon bulb in parallel with which is a spark gap. These are joined between the centre conductor of the feeder and earth and little or no disturbance takes place in the impedance matching of the system. The neon flashes over whenever the static charge on the aerial (from a nearby lightning flash or charged rain) exceeds 100 V, while a heavy accumulated charge will jump the gap. This device is housed in a weatherproof rubber container.

Several improvements in the indoor fittings used with television aerials are now becoming evident. Aerialite have a neat distribution and terminal box in which the insert carrying the connections can be removed for wiring and when re-inserted automatically earths the cable braiding to the box. Belling and Lee have some new distribution boxes for "loop wiring" of indoor aerial points, in which the cable is carried from box to box and not from a common feed point. It is for use mainly in communal installations and each box contains an impedance-matching resistance pad. The loop system of wiring is usually more economical in cable.

No large-scale television distribution system can be operated satisfactorily without one or more aerial amplifiers: sometimes a single amplifier at the aerial end of the system suffices, in others amplifiers have to be distributed at intervals throughout the system depending on the number of receiving points and the length of the cabling. E.M.I. have made a study of the requirements and have produced a range of one-, two- and three-stage amplifiers, self-sufficient with all power supplies and for use with a single receiver or large multi-point installation such as in hotels and blocks of flats.

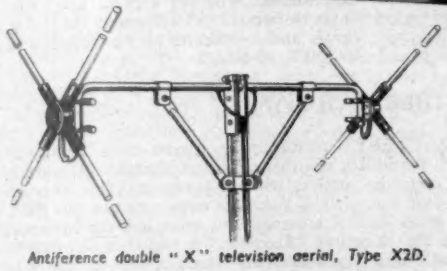
A single-stage amplifier giving a voltage gain of 100 and suitable for fringe areas is now made by Scophony-Baird, while one which is tunable over the whole band of television channels is produced by McMichael. The last-mentioned model needs an external power supply.

Several new signal generators for testing and aligning television receivers in the absence of a "live"

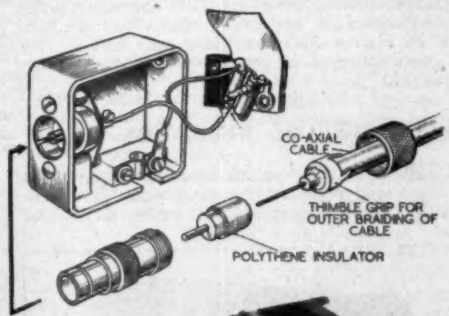


Left: Haynes Radio oil-filled r.f. e.h.t. unit removed from its sealed container.

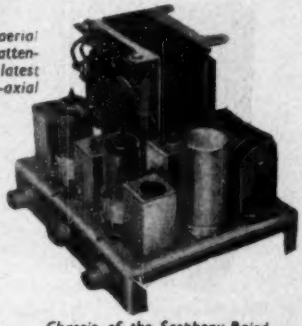
Chassis of E.M.I. 2-stage television aerial amplifier.



Antiference double "X" television aerial, Type X2D.



Belling-Lee television aerial termination box with attenuator net-work and latest "universal" type co-axial plug.



Chassis of the Scophony-Baird television pre-amplifier.

transmission have been developed recently. The Murphy Type TPG11, sold by Livingston Hogg, was described in *Wireless World* of February, 1950. It is now available in forms for testing 525- and 625-line receivers. One very versatile unit is the Waveforms

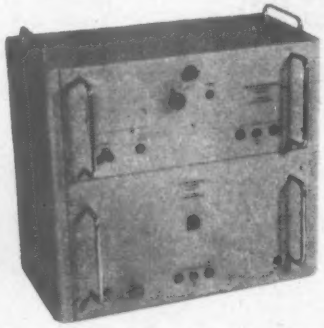
Waveforms model W90 television signal generator.

Model W90. It has two independent and tunable calibrated r.f. oscillators, one for sound the other for vision, with 1,000-c/s modulation for one and the choice of up to nine different forms of modulation for the other. These can be applied separately or in any combination. They serve for checking horizontal and vertical linearity, sync hold and bandwidth.

It is difficult to formulate an opinion of the line of development in television components from the recent show as it was by no means fully representative in this respect. Some fine examples of hermetically sealed and oil-filled flyback e.h.t. and line output units, r.f. oscillator units and e.h.t. transformers are now made by Haynes Radio and these may be a pointer to a continuation of the present trend of development in this field.

SPECIAL-PURPOSE RECEIVERS

ALTHOUGH the domestic broadcast receiver has been used more or less successfully in schools for reception of educational broadcasts, the School Broadcasting Council for the United Kingdom is strongly in favour of the use of specially designed equipment for this purpose. Some examples of this type of set were shown by Ekco, a typical installation consisting of a central radio receiver and audio amplifier with loudspeaker and remote-control units for use in classrooms. The audio output of this Ekco installation is 25 watts and it is capable of operating up to 16 loudspeakers simultaneously. Any number up to 15 can be switched off without affecting either the volume or the quality of reproduction of those remaining in operation. The radio receiver is a superheterodyne and has pre-set tuning for four stations, three in the medium waveband and one in the long, but any other combination can obviously be provided. Programme selection is effected by a rotary switch. Special care is given to the design of the audio amplifier, and a tone control is fitted to compensate for unusual acoustic qualities of different classrooms. There is a 10-watt and a 4-watt amplifier for use with the same radio receiver and also a gramophone unit with a self-contained amplifier for use in individual classrooms.



Ekco schools receiver ; this model includes a 25-watt audio amplifier.

Receivers designed for use in schools, workshops, clubs and wherever group listening is indulged in are made also by Grampian Reproducers. Three models are available giving 8, 15 and 25 watts output respectively. The radio unit of the 15-watt model is a superheterodyne with variable tuning covering either the medium and long wavebands or medium and two short wavebands according to requirements. Provision is made for use of two microphones and a gramophone turntable and separate volume controls are fitted for radio, microphone and gramophone circuits.

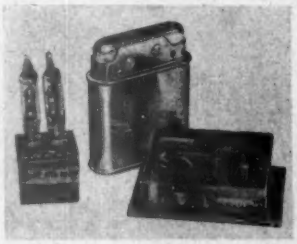
The size, shape and method of marking tuning scales are of far more importance in a communications and a special-purpose receiver than in a domestic broadcast set. The relative merits of semi-circular or straight-across scales are too controversial for discussion here, but some significance may be attached to the decision made by Eddystone to standardize as far as possible on the straight-line scale for all their communications receivers. This type of dial is favoured also by G.E.C. in their BRT400 communications set.

The full-width rectangular dial with straight-line scales used by Eddystone for their Model 750 is now fitted to the Model 680 which has been modified and housed in a new cabinet and is known as the Model 680X. A number of detailed improvements has been made also in the circuit.

Conforming to the same external appearance of the Model 680X is a new v.h.f. communications set, the Model 770M. It is a double superheterodyne covering in six bands 19 to 210 Mc/s and having a die-cast rotary coil turret. The set accepts a.m., f.m. and n.f.m. (narrow-band f.m.) telephony and c.w. telegraphy signals and it operates on a.c. supplies of 110 V and 200-250 V, 40-60 c/s.

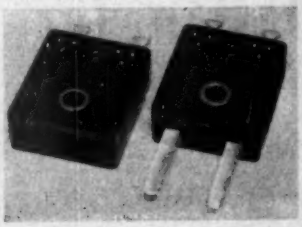
OTHER EXHIBITS

BATTERY manufacturers were not alone in reminding one that radio and electronic apparatus is somewhat useless without power supplies to work it, and a number of advances were noted in this field. A great deal of attention was attracted, for instance, by the Amplion "Activette," a small mains-driven unit which reactivates dry batteries before they run

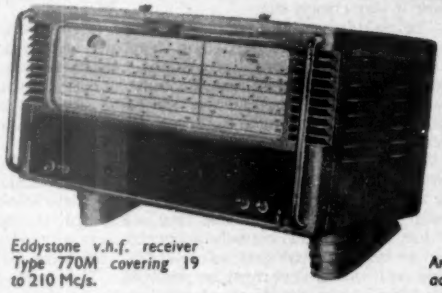


Moulded amplifier units by John Bell & Croyden.

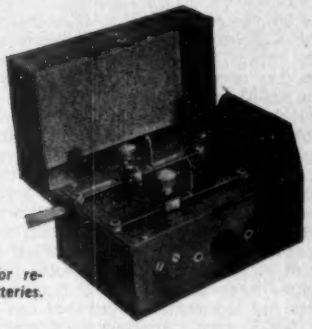
The blind man's Avo.



Bulgin unit connector, showing fixing holes.



Eddystone v.h.f. receiver Type 770M covering 19 to 210 Mc/s.



Amplion "Activette" for re-activating hearing-aid batteries.

down and so prolongs their life; the unit is discussed elsewhere in this issue.

Vidor, the makers of Kalium cells, which have four to seven times the life of the Leclanché type, are now concentrating on improved reliability, with X-ray examination as part of their manufacturing process. They were showing a new three-quarters U7 size on their stand. For those who have the wrong kind of power for their domestic sets, Valradio displayed a comprehensive range of vibrator converters; most of these were for obtaining suitable a.c. voltages from low-voltage d.c. supplies. Models for the higher input voltages include a commutating arrangement for switching in a surge-limiting resistor which helps to give something approaching a sinusoidal waveform. Among the stabilized power supplies on view the Ediswan general-purpose model was notable for its low price. The stabilized output is continuously adjustable over 120-250 volts, with variations of less than 0.1V for mains changes of 10V or load changes of 0.5 mA.

In the era of miniaturization it is not surprising that hearing-aid manufacturers should have something to offer towards the general technique. A notable contribution were the tiny "packaged" amplifiers shown by John Bell & Croyden in which all the parts except the valves were set solidly into a moulded block of synthetic resin. They have r.c. coupling and are available with one, two or three stages. One slightly larger model has an input stage, two phase splitters and a pair of push-pull valves giving a maximum output of 30mW. The firm applies the same technique to its miniature transformers, with the advantage of keeping the laminations insulated and at the same time rigid. Transformers generally are being reduced in size and weight by the use of the new grain-orientated C-cores, and a mains transformer shown by Whiteley was a typical example.

The other hearing-aid firm at the Show, Ossicaide, had an instrument fitted with a coil for direct inductive pick-up from sound-reproducing apparatus. Sufficient magnetic flux is set up by a loop of wire round a room fed from a loudspeaker speech coil or by the transformer in a telephone handset.

Technical aid is also a blessing to those who have lost their sight. At the Show it came, appropriately enough, to the blind technician, in the shape of a universal Avometer fitted with a Braille scale. To enable the user to take a reading by touch, an external pointer, pivoted at the same place as the ordinary pointer, is moved across the Braille scale and when it reaches the same deflection it falls perceptibly into lock.

The apparently simple task of making an electrical connection has considerable ramifications in all branches of the art. Making soldered connections is one of the biggest jobs in the production of domestic receivers, and on the Multicore stand was a complete assembly line from the Ekco works (pretty girls and all!) demonstrating at what speed this can be done with resin-cored solder. The technique of connecting complete units together was represented by various plug-and-socket systems; Belling-Lee had a new 18-way miniaturized connector, while Bulgin were showing some versatile two-pole plugs and sockets which could be bolted together and grouped in various ways for as many circuits as necessary. Dubilier showed some resistors with improved connections between the leads and the element, giving not only low-resistance contact but a means of rapidly conducting heat away.

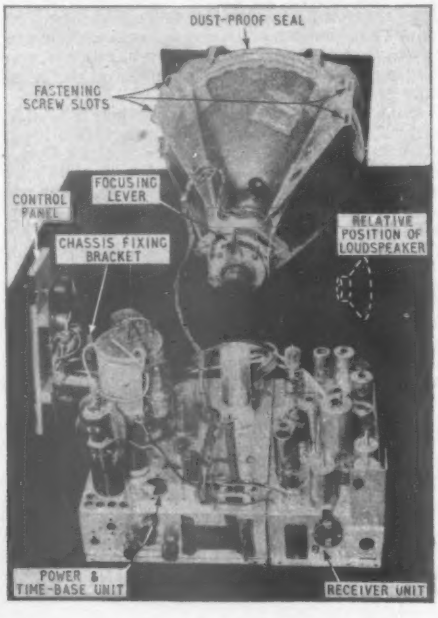
Design for Servicing

By M. G. SCROGGIE, B.Sc., M.I.E.E.

Examples of Better Accessibility at the Radio Show

IT is no secret that the radio industry and trade are seriously concerned about the servicing problem. The servicing problem, briefly, is this: The spread of television over the country is rapidly increasing the number and complexity of sets that are liable to need skilled attention. Many dealers have had no previous experience of television. Technicians with sufficient intelligence, skill and training reasonably expect an appropriate income, and apart from that they now possess a scarcity value. Radio dealers, who are obliged to pay the technicians (unless they do everything themselves) and a great many other expenses besides, have to make a profit or go out of business. The public, when they have parted with a substantial sum for a television set and the 66⅔ per cent tax, and the licence, and the aerial, are not unnaturally grieved if they are charged heavily for repairs and replacements, including certain costs during the guarantee period. If the sets themselves are trackless mazes of more or less inaccessible parts, difficult to remove from the cabinet and requiring various supports and mountings before they can be worked on the bench, even competent servicemen use up a lot of expensive time on them, and the less competent cannot cope at all and the set has to go back to the maker while the owner is prevented from enjoying a long series of the unusually desirable programmes that always begin on such occasions.

Ekco "Triple-Link" television receiver with units removed from cabinet.



I have referred exclusively to television, because it has greatly intensified the problem, but in a less acute form it was always there.

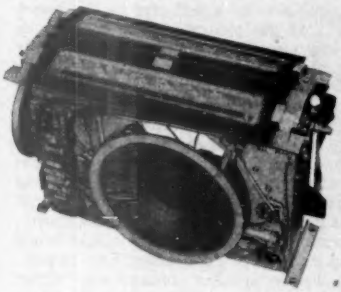
The recruitment and training of more service technicians has been considered and discussed at length, but clearly that alone is not the whole answer, especially when it has to compete with the rearmament programme. A more effective means of attack lies with the designer to make the sets quick and easy (and therefore cheap) to service.

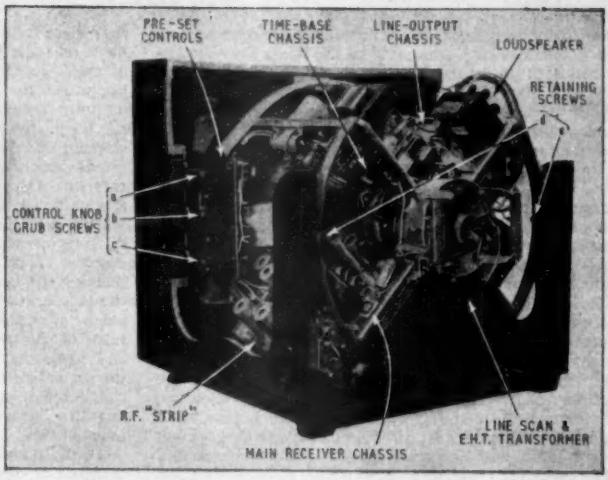
What makes a set quick and easy to service? Foremost, perhaps, all the parts must be readily accessible for adjustment, repair, or replacement. Since a television set of which this was true while still in its cabinet would be a criminally dangerous article to sell, it must be presumed that before serious work can be done on it the cabinet must be removed. This operation alone offers much scope for intelligent design. Some sets we have known left one to guess which screws ought to be removed to release the chassis and which would merely cause premature collapse. Then, when various leads had had to be unsoldered (because one did not have six or seven hands to remove chassis, control panel, loud speaker, etc., simultaneously) it was necessary to remember which lead went where and to solder them all up again, and prop the units precariously about the bench before the set could be switched on.

The aim, then, should be to enable one pair of hands to remove everything in a few moments and have it all on the bench in a connected-up condition. Without any special fitments, and without risk of damage to the parts, the whole set should be capable of being stood up in such a way that all the relevant controls, pre-set adjustments, trimmers, valves, components, metering and oscilloscope points, should be accessible, and at the same time the screen should be viewable, without having to twist oneself into awkward attitudes or run unnecessary risk of electrocution. Finally (assuming that everything can be put back into the cabinet as easily as it came out, without upsetting any of the adjustments), the whole set should be so arranged that important sub-assemblies can be quickly detached and replaced. In this way, even if the work to be done does not come within the powers of the dealer or serviceman, there is the option of plugging in a spare unit so as to let the owner have his set back with the minimum of delay.

So much for the problem and its solution in general terms; now for some actual examples. Rather than attempt to refer to every model seen at the Radio Show illustrating some aspect of the matter, it seemed better to describe in some detail a few outstanding examples of consideration for the serviceman. If most of them are television, that is not for lack of other examples but just because the problem is both more

Ferranti Model 515 receiver with cabinet removed to show accessibility.





Right : Murphy V200 television receiver (with cabinet partly cut away). Only the loosening of screws a-e is required for removal.

difficult and more recent with television. A walk round the Show gave the impression that there is now little to complain of as regards accessibility of sound-only receivers. Whereas a few years ago there was a heavy rectangular chassis on the floor of the cabinet, which had to be unscrewed from below (and was difficult to replace because there was no support for the weight while the screws were being refitted), and often could not be removed without unsoldering leads from the separately mounted loud speaker, the modern chassis is smaller and lighter, has an integral loud speaker, and there is a tendency for the components to be mounted in vertical planes, like the walls of a house. A good example is the Ferranti 515 transportable, the cabinet of which can be removed by taking out four screws, leaving the chassis standing with everything in view. The frame aerial pulls aside to give better access to the relatively few interior components.

The "baffle" type of construction that Murphy have favoured for some years now also makes for accessibility, as the chassis is necessarily very shallow. The A188C "Baffle" Console is a current example.

But good design for servicing can almost be taken for granted in this field, so let us proceed to television, where design is more fluid. There can be no doubt that a great deal of thought has been given to the problem of mounting a large and fragile c.r.t. and a vast assortment of smaller components in a conveniently small cabinet while achieving the desiderata for servicing. In what may be called the conventional or original style there is a large horizontal rectangular chassis, with the c.r.t. mounted above it, reducing the chassis area where things can project above the deck. For small table models the loud speaker has to be mounted at the side, either separately, which calls for an unplugging device, or on the chassis, in which case there may be difficulty in withdrawing the chassis through the back of the cabinet. (Ferranti overcome this difficulty by arranging for the speaker to move backwards a short distance when the mounting is slackened.)

The general outline of this construction is still followed in many makes, but almost invariably there is a tendency to subdivide the deck so that sections of it can be easily removed. This is, of course, particularly true of the stages that determine the r.f. tuning, for in many models there is an interchangeable "r.f. strip" to enable them to be fitted for the appropriate channel. Those firms that include models with or without medium-wave sound usually supply the same main chassis for both, with an optional section for the former.

If the entire set is mounted as one whole, the desire to enclose it in the smallest possible cabinet is likely to lead to cramped layout, and there are difficulties with side-mounted speakers and controls, and perhaps in seeing the screen properly while making adjustments at the rear. So some makers have decided in favour of separate units, and the question then arises of interconnections and easy withdrawal from the cabinet. A good example of an answer to this question is the Ekco T161 "Triple-Link" (see previous page). C.r.t., control panel, loud speaker, and main chassis are separate units; and the chassis itself is really two bolted together, one comprising the receiver unit and the other the time-base and power circuits. For many adjustments (including channel-setting) it is not necessary to take the set out of the cabinet at all, for the underside of the chassis can be exposed by a removable floor, and the upper parts by removing the back. But if total uncovering is necessary, it can be done in a very few minutes. C.r.t. and side-mounted loud speaker are both disconnectable by plugs. The chassis is released by two screws along the rear edge, the front being held by spring-loaded metal "upholstery buttons" on the cabinet floor, engaging slots in the chassis, which can be slid out from them. The control panel, joined by a flexible cable, comes away when a single wing fastener is turned. So that it need not float loose about the bench, it is provided with a bracket by which it can be firmly screwed to the front of the chassis. The 12-in c.r.t. is held, complete with mask assembly and dust-proof seal, in a light metal frame, which can be unscrewed from the cabinet roof. This enables the otherwise cumbersome and fragile tube to be handled easily and safely, and stood on the bench in a convenient position for viewing during the work.

Another welcome feature for the serviceman is

that the component fixing screws have no loose nuts to be handled on the other side of the deck; they are integral with the chassis.

The Philips 1101U comprises four units, but although they are quite easily separated by undoing a few screws and pulling out connector plugs, it is not normally necessary to do so except for replacing a complete unit. The cabinet is so constructed that back, top and sides can be removed by undoing four coin-slot screws, leaving the "works" *in situ* with the front of the cabinet and its floor frame. The floor itself can be taken away by unscrewing, to get at the under side of the chassis. A metal framework enables the whole set to be stood on its head or sides without damage. The four units, shown in the photograph, are: (1) receiver chassis, (2) power and time-base chassis, (3) control panel and front-facing speaker, and (4) c.r.t. focusing and scanning unit. An interesting feature is the channel-changing system. On the deck of the receiver chassis there are three B9G valve-type holders, distinguished by colour coding, into which plug a set of cylinders 1in long by $\frac{1}{4}$in diameter containing tuning coils, numbered according to the television channel. The only other operation is to adjust a single trimmer for maximum sound.

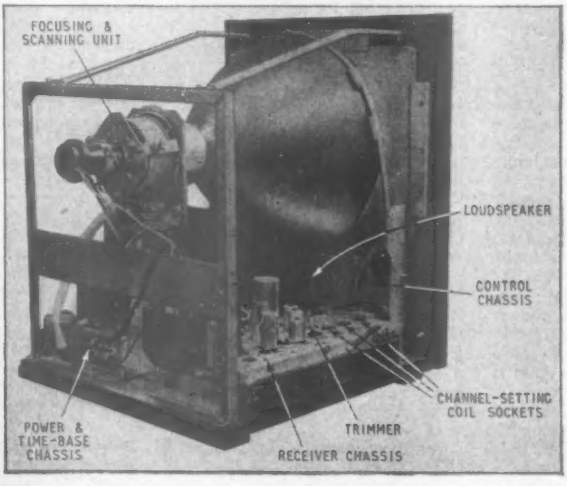
The Philips scheme neatly dodges the control-knob difficulty, which is complicated by the prevailing live-chassis technique since the control spindles must be thoroughly insulated from the user. Another solution is the English Electric edgewise knob, which does not have to be removed when withdrawing the chassis.

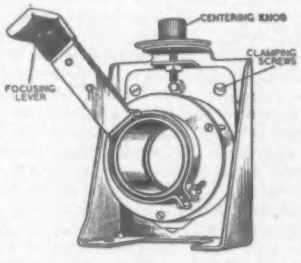
Although the Murphy V200 table model has been described in this journal quite recently,* it can hardly be omitted from a review of this kind, for it is the most unconventional of all. The underlying idea is that owing to the awkward shape and size of the c.r.t. the conventional chassis wastes a large proportion of the space in even the smallest possible cabinet. Adding an upper deck parallel to the lower conflicts with accessibility. But in the V200 the decks are at right angles to one another, four of them being arranged radially with the neck of the c.r.t. as their axis. In this way they do not obstruct one another and there is plenty of room for all the components. It would seem that there is also something to be said for the arrangement as regards cooling. The wheel-like appearance of the structure is increased by the circumferential hoops, which enable it to be rolled over on the bench without damage. As the picture shows, there is an r.f. strip along the outer edge of the main receiver chassis; this can be changed, to adapt the set to a different channel, through the removable bottom of the cabinet. On occasions when it is necessary to uncover the whole set, it is done merely by loosening two nuts, one on each side of the rear hoop, and three control-knob grub screws, enabling the knobs to be withdrawn. The whole structure can then be slid out through the back of the cabinet. The loud speaker is the only unit left behind; it is automatically disconnected by withdrawal of the chassis, which is held in the front of the cabinet by lugs push-fitting into sockets, and these serve also as speaker connections. When the set is being run on the bench these lugs should be connected to a speaker, an artificial load, or (lacking anything better) short-circuited, to avoid risk to the output valve.

The Ultra table model is less revolutionary but the designer obviously kept the servicing viewpoint prominently in mind. Among features that are likely to appeal are the prop stand (a strip of metal that pulls out from the side to enable the chassis to be rested conveniently on the bench), easily detachable e.h.t. unit, quick-release c.r.t. mounting, and an exceptionally convenient picture-centering adjustment. Slackening two screws releases a spindle by which both vertical and horizontal adjustments can be made with one hand—by screwing up and down and moving from side to side. It is then clamped by retightening the screws.

The projection type of receiver is generally not too difficult to lay out, because there is no large c.r.t. and it can be assumed that there is a console type of cabinet to roam about in. But unless the matter has been considered during design the serviceman may have some trouble in seeing the picture properly while adjusting the optical system. Etronic (for example) provide for this by a quickly removable front panel to the cabinet, giving access to the projector from that position.

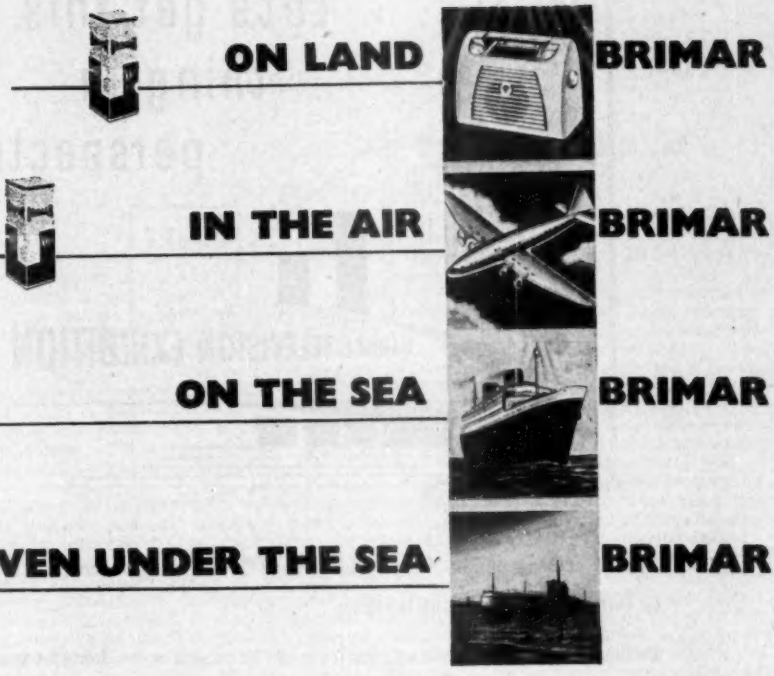
* August 1951, page 324.





Ultra focus unit, with knurled, insulated knob for picture centering. The picture does not shift when the knob is released nor when the clamping screws are tightened.

Left: Philips 1101U television receiver opened up for servicing. It has a metal frame, from which the back, top and sides have been removed by undoing four coin-slot screws.



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"FMQ"

By W. S. MORTLEY, A.M.I.E.E. *

Circuit Giving Linear Frequency Modulation of a Quartz Crystal Oscillator

THE Marconi "FMQ" system was devised in order to obtain a simpler and more reliable frequency modulating circuit than existing systems, whilst maintaining adequate carrier frequency stability and low distortion. The title, the initial letters of "Frequency Modulated Quartz," should be interpreted literally. That is to say, in this system a quartz crystal oscillator is *frequency* modulated, not phase-modulated by a signal of modified frequency response (amplitude inversely proportional to frequency), as are many systems. Thus it is capable, basically, of being modulated by d.c. as in frequency shift keying.

The first difficulties likely to be encountered in such a system are those of obtaining sufficient frequency deviation and sufficiently low distortion. Clearly some kind of "reactance valve" circuit has to be used and it is important to consider the relation between input voltage and "reactance" of such a device. It is almost general practice to obtain the "reactance" by feeding an r.f. signal from the output of an amplifier back to the input via a quadrature network.

A simplified arrangement of one particular type of circuit for achieving this is shown in Fig. 1. The amplifier valve takes a leading current and appears to a circuit connected across the terminals as a capacitance whose value (approximately $g_m RC$) varies linearly with the value of the valve mutual conductance. Over small ranges of frequency, such as are required for f.m., linear modulation will be achieved if such a circuit is connected across an oscillator parallel tuned circuit, and the g_m of the amplifier valve is varied linearly with the applied modulating frequency. Such a modulatof really results in a linear variation of susceptance, rather than of reactance, and would be more appropriately termed a susceptance modulator.

The effective electrical circuit of a crystal with plated electrodes, in the neighbourhood of a resonance, is shown in Fig. 2 and will be seen to be composed of a series resonant circuit L_c, C_c, r_c, in parallel with a capacitance C_p. The series resonant circuit is the electrical effect (as measured at the terminals) produced by the mechanical resonance of the quartz plate in conjunction with its piezoelectric properties and C_p is the ordinary electrical self capacitance. Ignoring, for the moment, the embarrassment of C_p, we find that we have a series circuit where we want a parallel one and that its impedance, in any case, is quite unsuitable. However, it is a well-known property of a quarter-wave line, and of its lumped equivalent, that the admittance measured at one pair of terminals is proportional to the impedance connected to the other pair. Series circuits are transformed, or "inverted," to parallel circuits. Thus the equivalent series crystal circuit of Fig. 2, will be inverted by an equivalent quarter-wave line (such as that in Fig. 3) to the parallel circuit of Fig. 4, if C_p is included as part of the adjacent capacitor of Fig. 3. Clearly we do not want to invert the whole crystal circuit (i.e., including C_p) because then there would be an equivalent inductance in series with the equivalent parallel circuit measured at the far end of the line and this could not be modulated linearly by a normal susceptance modulator. For this reason C_p is made to vanish by including it as part of the quarter-wave network. A quarter-wave circuit always inverts accurately, but when the frequency is changed a fixed network ceases to be a quarter-wave network and therefore introduces some distortion. However, for small changes of the order of plus or minus one or two parts in a thousand, which is all we require, the approximation resulting from fixing this circuit is sufficiently good. It is found that alteration of the value of the capacitance in parallel with C_p produces second harmonic distortion of sign depending upon the direction of the error, so some other distortions in the system could be balanced by this means although, in fact, it has not been necessary. Varying the other condenser, of course, is similar to varying the modulator susceptance, and varies the carrier frequency linearly with capacitance. It should

* Marconi's Wireless Telegraph Company.

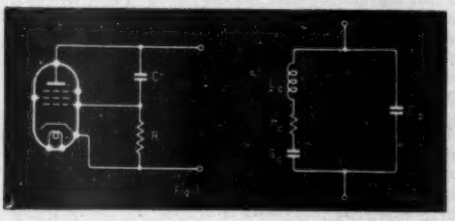
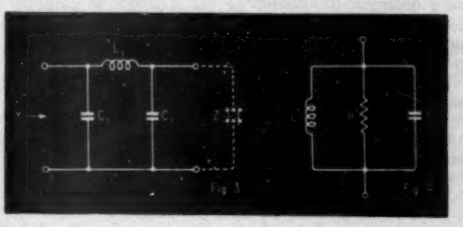


Fig. 1. Simple reactance valve circuit.

Fig. 2. Effective electrical circuit of crystal near resonance.

Fig. 3. Equivalent quarter-wave network. When $\omega^2 L_1 C_1 = 1$, $Y = (C_1/L_1)Z$, where Y is an admittance and Z is an impedance.

Fig. 4. Equivalent circuit of crystal and quarter-wave network. $L' = L_1 C / C_1$, $R' = L_1 / C_1 r_c$ and $C' = C_1 L_c / L_1$.



be noted that variations of frequency obtained in this way do not cause any change in the value of the circuit dynamic impedance R′. Therefore oscillation may be maintained without amplitude modulation by connecting any suitable oscillator circuit presenting a parallel resistance of $-R'$, provided that it is connected at the modulator end of the network and not at the crystal end, where the impedance varies widely. One precaution has to be taken. That is to ensure that the oscillator feedback is less at the resonant frequency of the quarter-wave network ($\sqrt{2}f$ with no modulation) than at the crystal frequency. It tends to be greater because this mode does not include the crystal loss.

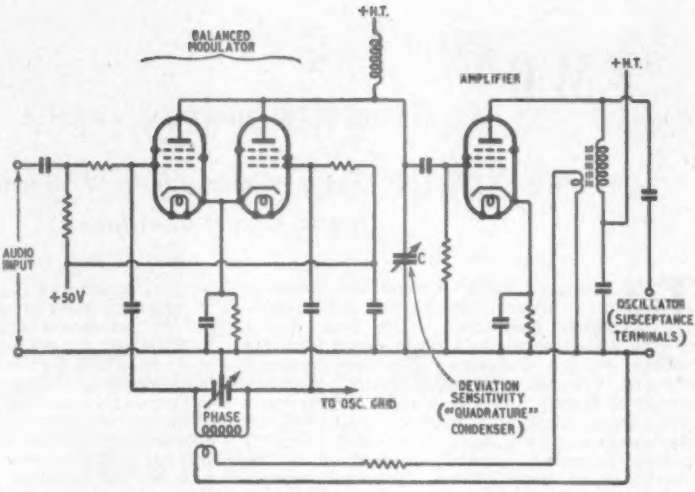


Fig. 5. Three-valve "susceptance modulator" circuit.

The other problem we mentioned was that of getting enough deviation. The maximum deviation possible is limited by degradation of frequency stability, by distortion, or by the modulator capabilities. In the B.B.C. model* the value of C′ (Fig. 4) is of the order of 0.01μF at 3.8033Mc/s. To modulate this by ± 1 part in 1,000 requires a maximum susceptance of ±0.008mho. In this case, for a modulator which can handle 10mA r.m.s. linearly, the oscillator amplitude must be kept below 2.3 volts. In this equipment it is kept to about 1 volt r.m.s. by means of an "automatic level control" circuit (this is similar to an a.g.c. system, but applied to an oscillator). This control has the further advantag of suppressing any a.m. which may arise from circuit imperfections.

Centre-frequency Stability

The next problem which arises is that of carrier frequency (centre frequency) instability, not in the oscillator itself, which is much more than adequately stable when supplied with a crystal of low temperature coefficient, but in the modulator. The current specification is that the maximum deviation should be ±100kc/s at the carrier frequency and that the centre frequency should never deviate by more than 2kc/s. This means that the modulator unmodulated mutual conductance must never change by more than ±2 per cent of its linear range, and this is a very severe requirement. The first and obvious precaution is to use a *balanced* modulator so that changes in cathode heating, for example, cause approximately equal and opposite effects. Certain design arrangements may be used to encourage balance, but, in the last resort, it is best to choose matched valves. The second precaution to take is to choose valves with a long linear range of g_m versus E_g as near the lower end of the characteristic as possible. The third precaution is to choose a valve whose mutual conductance does not change in jumps when the cathode temperature changes, as some valves do. The valve which has been found to satisfy all these requirements and, very importantly, to be a quiet valve, is the Mullard EF37A. Unfortunately, the variation of mutual conductance by a pair of these valves is not great enough by itself, and neither is their current-handling capacity, so an r.f. amplifier valve is added. This has no influence on centre-frequency stability and so it is not limited to any particular type and is chosen mainly for its current-handling capacity.

This three-valve arrangement is shown in Fig. 5, and, although it is a good deal more complex than the circuit shown in Fig. 1, it operates on the same general principles. R.f. is fed to the modulators via a phase-splitting transformer, one grid being fed in phase with the oscillator output and the other in antiphase. The capacitor C forms the common anode load, which, in conjunction with the high anode impedances of the valves, produces nearly 90 degrees phase change. With no applied modulation, assuming perfect balance, the voltage across C is zero and the frequency is unchanged. When the balance is upset by modulation, however, the amplifier takes a leading or lagging current, depending on which modulator valve is predominant. The r.f. phase relationships for a perfect set-up are shown in Fig. 6.

The capacitor C is made variable to provide control of deviation sensitivity (i.e., kc/s deviation per volt of audio input). The centre-tapped phase-splitting transformer is tuned by a split-stator capacitor. This gives an adjustment of phase, and the presence of the tuned circuit in the reactive loop gives some protection against parasitic oscillations which might otherwise occur, particularly on over-modulation. One side of this tuned circuit is coupled back to the oscillator grid to maintain oscillation.

Only single-sided modulation input is required as the modulator pair acts as an a.f. phase-splitter, the cathode impedance being high and the second grid being virtually earthed with respect to a.f. voltages.

With such a modulator it was found possible to

* Used at the Wrotham station

obtain quite linear modulation over a range of ±1 or 2 parts in 1,000, tested statically; that is to say, by applying d.c. modulating potentials and measuring the frequency. When tested dynamically, however, the story was very different. At various modulation frequencies peaks of a.m. appeared, accompanied by some f.m. distortion. It was apparent that unwanted modes of vibration more than two parts in a thousand away from the main mode were being excited by the f.m. sidebands. Efforts were made to avoid these modes by trial-and-error methods of crystal plate "dimensioning," bevelling, etc., without success. The unwanted modes varied in position in the frequency spectrum but were never absent. One significant feature was observed the unwanted modes were invariably higher in frequency than the wanted mode, usually within the range of 1 to 5 per cent higher. This was clue No. 1 to the source of the trouble. Clue No. 2 was the distribution of the amplitude of vibration over the surfaces of the crystals. In the main mode, the amplitude was always greatest in the centre of the contiguous electrodes, falling away to zero at the edges. In the first unwanted mode, the electrode area exhibited three antinodes along one axis. In the second, three along the other. In the third, three each way. In the fourth, five along one axis, and so on.

These divisions could not represent standing waves in the usual sense, as they were many wavelengths long in terms of the wavelength in quartz. Clearly they were due to an interference of waves travelling nearly normal to the surface of the plate and being reflected from the edges of the electrodes as in Fig. 7. This, with one exception, is precisely analogous to a cavity resonator terminated all round by waveguide stubs which are just smaller than the cut-off dimension. The exception is that the velocity of transverse waves in quartz varies with direction, whereas that in a waveguide or a cavity resonator is constant with direction. This remark, of course, applies to the free-wave components and not to the resultant wave, which has group and phase velocities different from this.

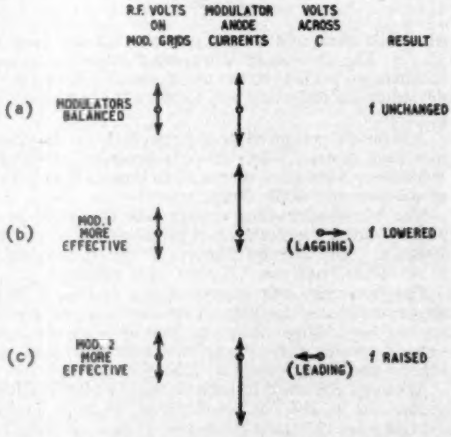


Fig. 6. R.f. phase relationships for a perfect set-up in balanced modulator.

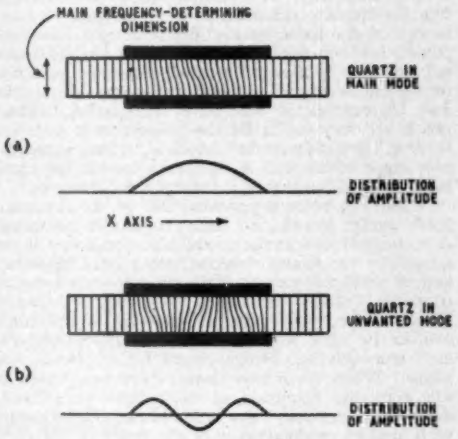


Fig. 7. Schematic diagram of section of quartz crystal showing wanted and unwanted modes of vibration.

Now the mathematics of cavity resonators and waveguides is well known, and by inserting suitable constants derived from experimental results it is possible to calculate all the unwanted frequencies and to design a plate so as to place the nearest of them outside the significant bandwidth of the system. Furthermore, by suitable choice of the weight of the electrodes (in relation to their size, the frequency and the "cut" of the plate) so that only the main mode is totally reflected at the electrode edges, higher frequencies are passed into the outer area of the plate. Thus the bare quartz surrounding the electrodes behaves as a waveguide filter. The edge of the plate is coated by a mechanically absorbent material which is a good acoustic match to quartz, so that the unwanted modes are completely damped.

It might be thought that if this absorption is so good it would be unnecessary to place the resonances outside the system bandwidth. This is not so, because were the cut-off frequency of the "waveguide" within the working band some significant f.m. sidebands would be absorbed, giving rise to distortion and a.m.

The design of these crystals is not simple, but a range suitable for broadcast f.m. with modulation frequencies up to 20kc/s has been designed for an extreme frequency range of 3.3 to 5Mc/s and a preferred range of 3.5 to 4.5Mc/s, and crystals made so far have been very successful indeed. The Q value in the wanted mode is between 100,000 and 200,000. Unwanted modes cannot be detected.

The output from the crystal oscillator is passed through a buffer stage, three doublers and a trebler (all heavily damped) to a drive output stage delivering about five watts at 85-108Mc/s to the main amplifiers of the transmitter as indicated in the block schematic diagram of Fig. 8. Thus the number of valves in the active chain, including a pre-emphasis valve, is only ten before reaching the carrier frequency. This is in contrast with the much higher numbers used in other systems, and results in greater reliability and less maintenance work.

Other valves and circuits are included in the drive unit for alignment purposes, and no external equip-

ment is necessary. A crystal reference oscillator and beat detector are included for datum frequency adjustment and for listening to "Bessel zeros." As most readers will be aware, the amplitudes of f.m. sidebands are governed by Bessel functions, which become zero for various orders of sideband with certain amplitudes and frequencies of sine-wave modulation. These points are very useful for the calibration of a direct-reading "deviation meter" which is, in fact, a modulation input voltmeter. A sine-wave modulating oscillator of fixed frequency is included for this test.

A listening point is provided also on the automatic level control system, so that a.m. can be detected. A.m. is produced at the modulation frequency if the modulator r.f. phase is wrong and at this frequency and its second harmonic if the quarter-wave network condenser across the crystal is wrongly adjusted. These two controls may be adjusted for minimum a.m. in the same way as one would adjust a particularly amenable a.c. bridge circuit for amplitude and phase. When these adjustments have been made in this way, the distortion of the system at ±75kc/s deviation is less than 1 per cent and the shift of carrier with applied modulation is of the order of ten parts in a million or less.

The shift of carrier with modulation is a feature which cannot occur with properly designed phase-modulation systems, but in the author's opinion this does not represent an advantage for those systems. Of itself, a small shift of carrier frequency with modulation is not important. What *is* important is that, if such shift does occur, audio distortion must be occurring also. Carrier frequency being easily observed, it provides a useful check on quality of transmission in a true f.m. system.

Many readers will ask the question: "If a crystal can be varied in frequency so much, what is its advantage over a tuned-circuit oscillator?" A little thought will show that there are many advantages. In the first place, no tuned circuit yet made has as good a thermal performance as a well-made quartz crystal. Even if the tuned circuit is compensated for temperature it will not have a very low temperature coefficient of frequency over a wide range of temperatures and it is unlikely that the compensating parts will react to temperature change at the same rate. Probably one of the nearest approaches to crystal performance is that of the well-known Marconi-Franklin drive, but even this is not nearly as good as the crystal, and it is far more expensive. Another important advantage is robustness. A tuned circuit is more likely to suffer from vibration effects and might be disturbed accidentally in a number of ways. A tuned circuit, too, is more subject to frequency drift. Finally, the high Q value of the crystal makes it possible to use a large effective capacitance, C′, in the oscillator, which reduces the effects of stray capacitance changes. The high Q value also reduces the effects of phase changes in the oscillator valve caused by changes in cathode coating impedance or of electron transit time.

The performance of an actual transmitter at its acceptance tests may be of some interest, though space restrictions forbid a full report here. The tests were conducted by using a monitor receiver (also designed and built by Marconi's Wireless Telegraph Co., Ltd.) and standard transmission-measuring equipment. All distortion figures obtained by these tests include those in both the transmitter and the receiver.

At the standard deviation of 75kc/s, the maximum

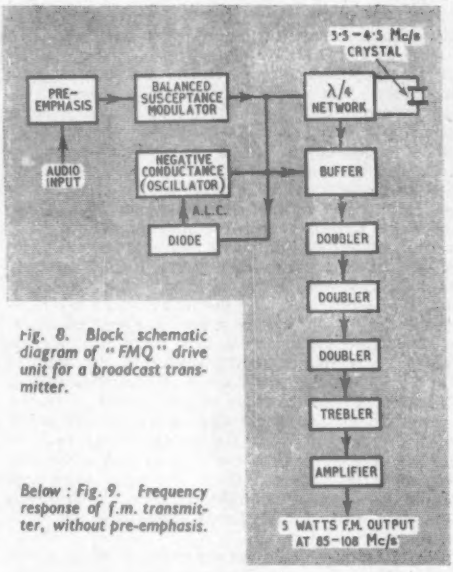
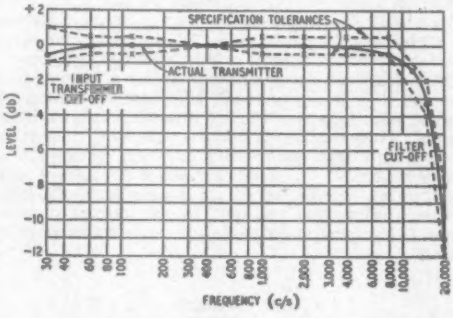


Fig. 8. Block schematic diagram of "FMQ" drive unit for a broadcast transmitter.

Below: Fig. 9. Frequency response of f.m. transmitter, without pre-emphasis.



distortion measured at the site was 1.2 per cent at 30c/s. The only cause of increased distortion at low frequencies is the input transformer. At 100kc/s deviation the distortion was found to be less than 1.5 per cent.

A.m. noise measured at the site with no deviation was 60db down. With 100-kc/s deviation at 400c/s modulation frequency it was 53db down. F.m. noise at the site was 60db down.

The carrier-frequency change was two parts in a million when the deviation was raised from zero to 100kc/s. The greatest change of carrier frequency in 48 hours' run was 12 parts in a million.

The frequency response is shown in Fig. 9, with no pre-emphasis applied. The droop at the top is applied by a filter circuit to comply with the customer's specification of approximately 3db down at 15kc/s and 10db down at 20kc/s.

Although the chief interest in the "FMQ" system centres on its use for broadcasting, it must not be thought that its use is restricted to this. It may be used, also, for f.s.k. (frequency-shift-keying), "diversity f.m." (anti-fading modulation), "privacy

f.m." (2-4c/s modulation) and facsimile f.m. In one design it has been possible to use only a single oscillator valve and one double-triode modulator valve to give sufficient linearity and deviation for f.s.k. and "diversity f.m." with 1 in 100,000 carrier-frequency stability.

Another use which has not been exploited much, so far, is that of a crystal oscillator, linearly variable over a frequency range up to about ½ per cent, for use as a local oscillator, a transmitter drive or an interpolation oscillator in frequency measurement. If equipped with a tuning motor and suitable circuitry a crystal drive of great simplicity and reliability can be made to follow the frequency of a highly stable but more complex oscillator, or a radiated carrier, if the signal is present, but to oscillate within Copenhagen tolerances if it is not. On the other hand, it must not be thought that "FMQ" is the answer to everything. For example, n.f.m. (narrow-band f.m.) communications equipment which does not use low modulation frequencies can make better use of phase modulation. Neither can "FMQ" be used for wide-band f.m. links for television or multiplex signalling.

The proper place for "FMQ" is for "d.c." or audio-frequency modulation applications where simplicity and reliability are of first importance.

In conclusion, grateful acknowledgment must be made to Mr. H. R. Cantelo, who did so much to encourage the adoption of the scheme in its early stages, to Mr. A. Miller, who carried out most of the final development of the transmitter drive, to Mr. and Mrs. D. Fairweather, and Mr. N. J. Beane, who co-operated in the manufacture of a satisfactory crystal plate, and to others in the Marconi Company who were concerned.

NEW BOOKS

Radio Installations. By W. E. Pannett. Pp. 444, with 244 illustrations. Chapman & Hall, 37, Essex Street, London, W.C.2. Price 45s.

The author is an executive engineer of long standing in Marconi's Wireless Telegraph Company and has been engaged on the overall planning and construction of radio transmitting and receiving installations for broadcasting and communication purposes for some thirty years. He has produced a book which, as G. M. Wright, chief engineer of Marconi's, says in his foreword, is "unique in the extensive literature devoted to radio communication."

In the preface the author points out that while most books on radio engineering are primarily concerned with theoretical expositions of circuits and valves for the student, his own approach is to the practising engineer whose work is to plan and construct complete installations and to deal either directly or indirectly with their maintenance and operation.

In this he has succeeded remarkably well and gives information of the sort which can only be acquired after many years of practical experience. This book contains much of what, in the present-day welter of specialized techniques, is almost becoming a lost art but which, in fact, must never be lost by those concerned with the practical design and operation of the wide range of modern transmitting and receiving installations.

The early chapters of the book deal with the selection of sites for broadcasting stations in the medium, high and v.h.f. bands, and also for transmitters and receivers for commercial communication, together with the general planning of the installation, including building requirements, foundations and layout of transmitters, auxiliaries and power plant. Power supply and distribution requirements for transmitters, including sub-stations, emergency generating plant and the characteristics which this plant should possess, are discussed, as well as power distribution switchgear, cabling and wiring and the selection of cables for audio-frequency and radio-frequency interconnections.

Two chapters are concerned with valves and their power supplies, with useful information on hot-cathode and mercury-arc rectifiers and their smoothing circuits for high-power transmitting installations.

Subsequent chapters deal with amplifiers and oscillators, the basic design of complete transmitters, modulating and keying systems, valve cooling plant and control and protective equipment. This information is rarely available, except in the engineering departments of a radio transmitter manufacturer or a broadcasting authority.

The author deals also with the practical characteristics and construction of radio-frequency transmission lines, impedance matching and aerial coupling circuits.

The two penultimate chapters are concerned with the general principles of communication receivers, complete commercial receiving installations and the equipment of control centres dealing with commercial radio-telephone and telegraph traffic. The final chapter, which deals with the problems of equipment maintenance and testing, is of special interest to the installing engineer and the station operator.

The book is valuable to the young installations engineer because it records the results of real engineering experience. Furthermore, he will not wish to part with it as he becomes more senior in his profession because, as a book of reference, he will still find its contents of great value.

P. A. T. B.

Magnetic Recording. By S. J. Begun. Pp. 232+XVIII with 145 illustrations. Thermionic Products, Ltd., Morris House, Jermyn Street, London, W.1. Price 25s.

WRITTEN by the chief engineer of the British Development Company of America, this book gives a broad survey of the state of the art of magnetic recording up to 1948.

The opening chapter on the history of magnetic recording traces the subject back to an article by Oberlin Smith in the *Electrical World* of 1888 and includes a more detailed account of Poulsen's pioneer work than is to be found in most sources.

A condensed chapter on the factors in acoustics relevant to sound recording follows, and leads to a detailed examination of magnetic theory and its application to recording with d.c. and a.c. bias, the origin of background noise, demagnetization and the "gap effect" in relation to the recording and playback of high frequencies.

In dealing with magnetic recording materials, and later with descriptions of complete machines (nearly thirty are dealt with), the emphasis is on homogeneous wires and tapes, but the German Magnetophon and four American machines are included as representatives of the alternative method of using coated plastic tapes. This is only to be expected since the book went to press before the present spate of tape recorders appeared on the market.

As far as principles are concerned, however, the text is equally applicable to wire or coated tape, and the book can be recommended to those seeking an introduction to a subject which, as the author points out in his preface, is still in the stages of adolescence.

Useful references to European as well as American sources of information appear at the end of each chapter.

F. L. D.

FURTHER NOTES ON THE

T-Match Television Aerial

Choice of Materials, Method of Construction and Dimensions for all Television Channels

By B. MAYSON

THE description of the T-match television aerial[1] aroused considerable interest at the time of its publication, and more recently requests have been received for the design of one for the Holme Moss frequency, so that it seems opportune for some further notes on the subject.

As will be remembered from the original article, the general form of the T-match aerial is as shown in Fig. 1, in this case a three-element system is illustrated. To begin with, it is desired to single out two of the several features which, in the writer's opinion, make this type of aerial so very attractive. First, exact aerial-to-feeder matching is possible; second, the whole of the metallic structure can be earthed, providing not only protection against lightning but also a means of draining static charges to earth and thereby reducing receiver noise.

There is some difference of opinion regarding the theory of the T-matching device, but while a full discussion of the subject is outside the scope of these notes, a few general remarks might help to clarify the situation. With reference to Fig. 2, we know that as the tapping points B are moved towards A the impedance at the feed point D decreases; conversely, as the tapping points are moved towards C the impedance at the feed point increases. Thus, by positioning the tapping points correctly, we can match the feed point exactly to any line, or cable, of an impedance up to 300 ohms, providing the matching rods are of the same diameter as the aerial rod. Why 300 ohms? Because when the tapping points reach the extremities of the aerial rod the T-match ceases to exist and we are left with a two-element folded dipole, which is well known to have an input impedance equal to four times that of a half-wave rod of 75 ohms nominal impedance. Incidentally, by using matching rods which are unequal in diameter to the aerial rod, we can achieve a multiplication factor higher than four.

Returning to the general case, it should be noted that the addition of parasitic elements (directors and reflectors) to a half-wave dipole not only increases the gain, but also lowers the centre impedance. Table 2 gives the approximate values of the feed impedance of some typical arrays.

Dimensions.—The dimensions recommended originally for the two-element aerial have proved satisfactory in practice, as have the dimensions of a three-element system which has since been tried out in various localities. The data has now been extended to cover all the five projected television channels and is included in Table 1, which should be used in con-

[1] "T-match Television Aerial." *Wireless World*, Jan., 1950.

TABLE I.
Dimensions of Aerials

Station	Vision Freq. Mc/s.	Type of Aerial	Dimensions in inches.						
			A	B	C	D	E	F	G
Alexandra Palace ..	45.0	2-Element	134.0	129.0	42.0	3.0	26.0	—	—
		3-Element	134.0	129.0	42.0	3.0	22.0	26.3	123.8
Holme Moss	51.75	2-Element	116.3	111.7	36.5	3.0	23.0	—	—
		3-Element	116.3	111.7	36.5	3.0	19.0	22.8	107.2
Kirk O'Shotts ..	56.75	2-Element	106.2	102.0	33.3	3.0	21.0	—	—
		3-Element	106.2	102.0	33.3	3.0	17.5	20.8	98.0
Sutton Coldfield ..	61.75	2-Element	97.5	93.5	31.0	3.0	19.0	—	—
		3-Element	97.5	93.5	31.0	3.0	16.0	19.3	89.8
Wenvoe	66.75	2-Element	90.2	86.6	28.3	3.0	17.5	—	—
		3-Element	90.2	86.6	28.3	3.0	15.0	17.7	83.0

junction with Fig. 1. The approximate figures given in Col. E assume that the matching rods and the aerial rod are of equal diameter.

Comparatively few readers will require a four-element aerial, but when it is needed it will only be necessary to add a second director to the three-element type in Fig. 1. From Table 1, the spacing between directors can be as Col. F; the length of the second director as Col. G minus 3 per cent; while the initial setting of the matching adjustment, as in Col. E (three-element) minus 14 per cent. These dimensions will provide a starting point.

The Matching Section Insulator.—A modified version of the matching section is given in Fig. 3, which differs from the original in respect of the insulator only. There appears to be some uncertainty regarding the permissible length of the insulator separating the adjacent ends of the matching rods, and regarding the insulator itself. As regards length, 1 in is satisfactory and up to 2 in permissible. Obviously, a short insulator permits the cable attachment to be made without any undesirable splaying of the cable ends. As for the insulator itself, the one used on the original aerial came out of the scrap box and cannot now be identified. However, a suitable alternative can be made quite easily. Referring to Fig. 3, it will be seen that the porcelain insulator specified originally is replaced by a short length of insulating rod pushed into the adjacent ends of the matching tubes and adjusted so that the ends of these tubes are 1 in apart. Provided the insulating rod fits tightly there is no need to pin it. In order to increase the leakage path of the insulator a disc, E, may be fitted as shown.

For the insulating rod we require a material with a low loss factor at television frequencies, low moisture absorption, high resistance to the effects of outside exposure, and so forth. Now as far as the first requirement goes ordinary porcelain does not show up well since it has a high power factor at 50 Mc/s. Polystyrene or Polythene will do very nicely, the latter being the easier to work. Otherwise we can use Paxolin, which is easily obtainable. The disc need not be of the same material. Perspex has been used with every satisfaction and fixed in place with Bostik compound.

Adjusting the Matching.—Theoretically, the matching procedure is simple. First set the matching strips (Fig. 3, C) in accordance with Table 1 (Col. E). Then, with the aerial connected to the receiver, set the brightness control (contrast control fully anti-clockwise) until the raster just shows, and then advance the contrast until a picture is received. Keep the contrast as

TABLE II.

Centre impedance and gain of aerial systems with element spacings as Table 1. (Without matching section.)

Type of Aerial	Centre impedance ohms	Gain in db over $\frac{1}{2}\lambda$ dipole
$\frac{1}{2}\lambda$ dipole	73	0
2-element	20–25	3
3-element	8–12	6–8
4-element	5–7	7–9

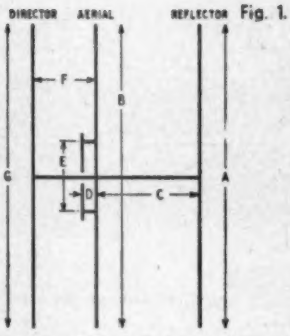


Fig. 1. General form of a three-element T-match aerial consisting of a director (G), aerial rod (B) and reflector, (A).

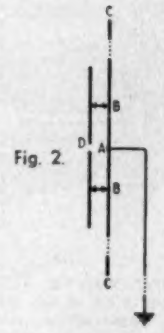


Fig. 2. Method of arranging a T-matching section.

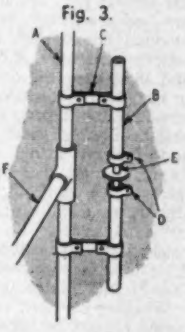


Fig. 3. Detail sketch of a T-matching section. A is the aerial rod, F the cross arm or boom, C the adjusting clips, D the cable connections, and E a disc to increase the effective leakage path of the insulator.

low as possible consistent with a steady picture. At the aerial end adjust the matching strips equally towards or away from the insulator until, at the receiver end, the best picture is obtained. Reduce contrast and repeat the process. If we remember that the contrast control of a television receiver is equivalent to the r.f. gain control of a sound receiver and that when the matching is correct the signal input to the receiver will be maximum, then there should be no difficulty in understanding the procedure.

Unfortunately the job is less easy in practice because, to get the optimum result, the adjustments must be made with the aerial *in situ*, a condition applicable to all matching systems except in the case of the aerial matching transformer.[3] If the aerial is to be mounted on a chimney, adjustment *in situ* is quite practicable with the aid of a helper who can signal from the receiver end. Incidentally, the point to watch here is to keep one's body out of the field of the aerial while the observation is being made.

If the aerial is to be mounted on a long pole the best thing to do is to devise a method of hauling the aerial up and down so that adjustments can be made. One word of advice: choose a windless day for this.

In the event of adjustment *in situ* being impracticable, the figures given in Table 1 (Col. E) will give reasonably good results. These figures, it should be noted, assume a feeder characteristic impedance of 73 ohms. But turning to Table 3 we see that we cannot be sure what the exact characteristic impedance of a given feeder will be in practice. How-

[3] "Aerial Feeder Connections," W. T. Cocking. (*Wireless World*, Dec., 1950.)

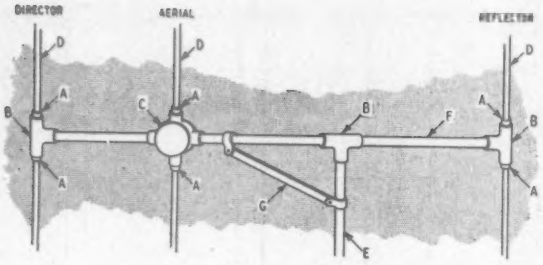


Fig. 4. Constructional details of a 3-element T-match aerial. Parts are as follows :— A, reducing socket 1in to ¼in ; B, 1-in screwed tee piece; C, 4-way circular junction box 1-in inlet or 4-way screwed junction socket if obtainable; D, ½-in dia conduit ; E, 1-in dia conduit for mast section, F, 1-in dia conduit cross-arm or boom ; G, support needed for 3- and 4-element arrays.

ever, with the T-match aerial, this point need not worry us in the least.

Construction.—Originally a heavy-gauge gas piping, gas fittings and Duralumin tubing were used, which resulted in a robust, but unduly heavy, structure. The obvious course for the constructor working with simple tools only is to use aluminium-alloy conduit and light-alloy die-cast conduit fittings, as indicated in Fig. 4. A three-element layout is shown here; the combination of parts for a two- or four-element type will be obvious from this sketch. Screwed conduit and screwed fittings are recommended. Generally, local suppliers will undertake to screw the ends of the conduit as required; the fittings, of course, are already screwed. Alternatively, if there is any difficulty in getting threads cut locally, some firms market conduit fittings which dispense with screwing. All that is necessary is to push the conduit into the fittings and tighten up with a screwdriver.

Whether screwed or gripped material is used, all points should be pinned where there is a likelihood of pivoting taking place due to the action of the winds. This applies particularly to the junction of the mast section and its "T" piece. Additionally, it is vitally necessary to pin the mast section so that it cannot turn in its lower-end holdings, and lack of attention to this detail can result in a television aerial changing its bearing subsequent to installation.

Following a study of Fig. 3, there should be no difficulty in constructing the matching section. A point to watch is to cut the matching rods some inches longer than shown in Table 1 (Col. E) to allow for adjustment. For the cable connecting clips, Fig. 3 (D), it is suggested a pair of double-screw earthing clips of ½-in diameter be used and these can be purchased along with the conduit fittings. A similar clip, but of 1-in diameter, can be used for attaching the mast section earthing wire. The adjusting strips, Fig. 3 (C), will have to be made up; for the original aerial ½-in soft brass strip of 20 s.w.g. was used.

Weatherproofing.—The necessity for weatherproofing will, of course, depend on the materials used. Most modern aluminium alloys have a high corrosion resistance, therefore painting need not be done. Where dissimilar metals are in contact, however, as in the case of brass adjusting strips and aluminium-alloy tubing, it will certainly be necessary to treat the junctions to prevent electrolytic action taking place.

TABLE III.

Characteristic impedance of some typical feeder cables.

Type	Overall size ins.	Nominal impedance ohms.	Actual impedance ohms.	Attenuation per 100ft. at 50Mc/s
Coaxial ..	¼	70	60–75	4db
Coaxial ..	½	50	48–60	6db
Screened twin	¼	100	90–110	4.5db
Unscreened twin ..	¼ × ¼	80	70–90	2.2db

TELEVISION RADIO LINKS

EXCEPTIONALLY long ranges are claimed for a new type of television link equipment recently supplied by E.M.I. to the B.B.C. Transmitted power of the sets is from 3-5 watts, generated by klystrons of new design, and it is stated that reliable "operational" signals have been obtained at distances of well over 45 miles. The wavelength is about 7cm and frequency modulation is used.

In addition to vision and sound channels, the equipment provides for two-way communication, so the producer of a television outside broadcast can keep in touch with the station from which the programme is being radiated.

As there is plenty of aerial gain to spare, the beam can be made wide enough to minimize difficulties in setting up the parabolic reflectors.

"Emitron" centimetre-wave link equipment for relaying television outside broadcasts.

THE "BELLING-LEE" PAGE

Providing technical information, service and advice in relation to our products and the suppression of electrical interference

Too much signal?

With the opening of the new transmitter we anticipate a substantial increase in our technical correspondence.

Problems are bound to arise; amongst these we forsee cases of aerial installations which give too high a signal level, necessitating the use of attenuators.

This condition is especially likely to arise in locations where an "H" type aerial has still to be used relatively close to the transmitter in order to combat interference.

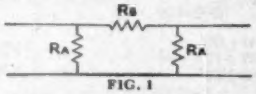


FIG. 1

Figure 1 illustrates a suitable attenuation arrangement for coaxial 80-ohm feeder, whilst Figure 2 shows an arrangement for 80-ohm twin feeder.

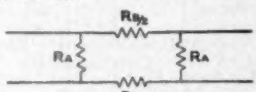


FIG. 2

In the latter there is a series resistor in each line, of half the value of the single series resistor R B shown in Figure 1.

Suggested value for various degrees of attenuation are as follows:—

Attenuation	RA	RB
6 db	240 ohms	62 ohms
12 db	130 ohms	150 ohms
18 db	100 ohms	330 ohms
24 db	91 ohms	620 ohms

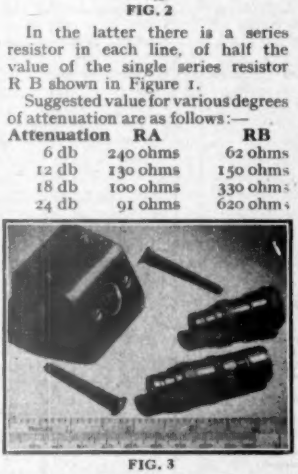


FIG. 3

We had hoped to manufacture a complete range of attenuators, but demand completely outstrips supply as at the present time there is a world shortage of resistors.

Illustration above (Figure 3) shows the "Belling-Lee" coaxial outlet box L.735 with line attenuators L.729 designed for insertion losses of 6, 12, 18, 24 and 36 db.

Using Television Aerials off resonance

Quite a lot has been written on this subject and we are often asked "what will happen if I use a London aerial on Sutton Coldfield?"

It is quite easy to see what will happen using a signal generator. What we are going to say applies to any ordinary aerials, i.e., it is not confined to our own or any other make.

Whereas a dipole is 5 or 6 db down, the real trouble starts when reflectors and/or directors are added. Then the deterioration is really serious. It is easy to be more than 20 db down compared with the response of the same aerial in the same field strength at its proper frequency. In plain figures, it means that this aerial picks up less than 1/10th of the signal. In other words a viewer with a 3-element channel 4 aerial trying to receive Holme Moss would, under typical conditions, be no worse off with an indoor aerial on the first floor.

We have carried out tests on the effects to polar characteristics when aerials are misused in this way. They show that in certain cases the directional properties are almost lost so that if, say a channel 4 dipole and reflector does pick up sufficient signal from Holme Moss to operate a receiver, it may not be able to afford sufficient discrimination against "ghosts" or interference.

It should not be necessary to remind readers of this page that the length of the crossarm is a function of the frequency of the aerial. Correspondence shows that many people still think they need only change the length of the elements. Information regarding conversion kits has already appeared here, but if any reader has missed this information we will gladly send him a reprint of the appropriate page.

Motor Car Ignition Suppression for Television and Car Radio

Even nowadays many people are not clear of the difference and why.

Distributor Suppressor L.630, screw in type.

All motor cars should be so suppressed that they do not interfere with Television. This is done by screwing a resistor suppressor in series with the lead from the coil to the distributor, at the distributor. This is insufficient if you are going to fit car radio. In this case you must, in addition, fit a plug sup-

Distributor Suppressor L.1274, side entry type.

pressor to each plug lead. Sometimes it is not practicable to fit a resistor to the distributor, in such cases a plug suppressor on each plug will be necessary.

Obviously a car fitted with normal car radio and adequately suppressed will not interfere with Television.

It may be worth mentioning that in suppressing a motor car, the presence of the bonnet supplies a measure of screening which is absent from some tractor types of vehicles. Such vehicles require plug

Sparking Plug Suppressor L.1143.

suppressors, as do motor-cycles and portable pumps, compressors, concrete mixers or similar appliances driven by a petrol engine.

How far on an indoor aerial?

An enthusiastic user of one of our indoor aerials writes that he is getting interference from vacuum cleaners. He goes on to state that whereas we only claim 8-10 miles as the sure range for our aerial, he is in fact using it 80 miles from the transmitter.

In our reply we pointed out that, in our opinion, the very fact that he was having trouble with interference was due to his expecting an indoor aerial to give satisfaction at such a distance. We feel that if he used a good outdoor aerial his signal-to-noise ratio would show a very considerable improvement. After all, 80 miles away from the transmitter is very much "fringe" area reception on any aerial.

BELLING & LEE LTD

P.S.

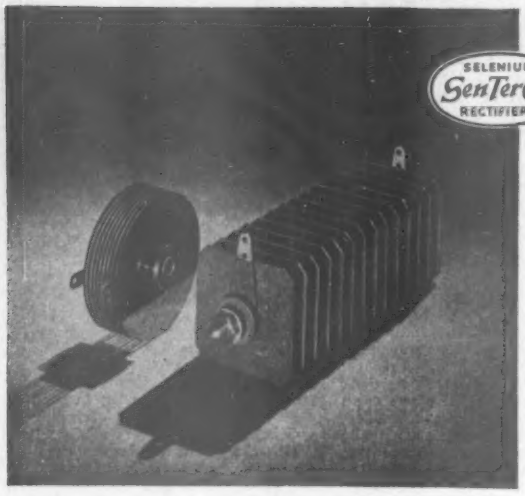
Did you know? A motor car can seriously interfere with electronic research and television reception.

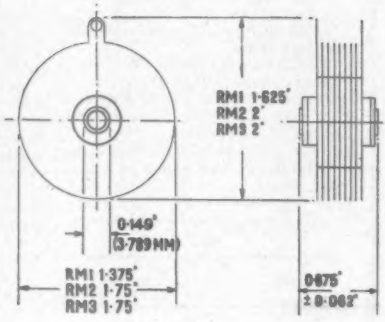
Fit a "Belling-Lee" suppressor L.1274 or L.630 to the distributor lead, does not affect engine performance and helps an industry

Light . . . robust . . . durable

SELENIUM SenTerCel RECTIFIERS

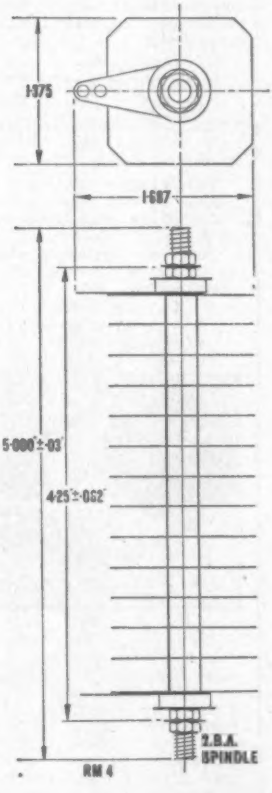
miniature H.T. Rectifiers





SenTerCel miniature H.T. Selenium rectifiers offer these unique features :

- Instant starting — no warming-up period
- Unlimited instantaneous overload
- No limit to size of reservoir capacitor
- Withstand overloads such as charging current of deformed electrolytic capacitors.
- Low heat dissipation
- Practically indestructible in service
- Simple mounting — no valve holder
- Simple wiring — two connectors only
- Small size . . . low weight
- Low cost



Ratings

TYPE	RM1		RM2		RM3		RM4		
Maximum ambient temperature	35°C	55°C	35°C	55°C	35°C	55°C	35°C	40°C	55°C
Maximum output current (mean)	60mA	30mA	100mA	60mA	120mA	90mA	275mA	250mA	125mA
Maximum input voltage (r.m.s.)	125V		125V		125V		250V		
Maximum peak inverse voltage	350V		350V		350V		700V		
Max. instantaneous peak current	Unlimited		Unlimited		Unlimited		Unlimited		
Weight	1 oz.		1.4 oz.		2 oz.		4.5 oz.		

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LETTERS TO THE EDITOR

The Editor does not necessarily endorse the opinions expressed by his correspondents.

The Modulation Battle

THE many letters to you on this subject seem to have entirely missed the obvious solution: the use of *both* systems.

A.M. can be received on existing receivers with the addition of a convertor; it would be an easy matter for manufacturers to include this in future sets. An a.m. receiver can be cheaply produced, but the f.m. system would be there for those who could afford the type of receiver which is necessary to take full advantage of it.

The export of f.m. receivers (a very important point) would be helped by a home demand.

North Harrow, Middlesex. FRANK BLACKBURN

YOUR report on Mr. Brinkley's paper (Sept. issue) appears to me to present a somewhat distorted version. For instance I cannot agree that Mr. Adorian's acceptance of a.m. on a short-term basis seemed to express the general feeling of the Convention.

This Convention was surely concerned with engineering* and not with one more display of our national rags and tatters or even with quasi-political discussions.

Dealing with the purely engineering aspect of the discussion I gathered that the only major item on which issue could be raised against the runaway superiority of f.m. over a.m. was on the band-width involved in the two systems. In my own measurements with comparative receivers for the two systems, I would emphatically point out that even where the a.m. receiver has been given a band-width of 200kc/s, the same as is required for f.m., the a.m. receiver is still at least one grade worse in its discrimination against impulsive interference. The noise limiter used with the a.m. receiver was of the rise time discriminator type, with an audio capability up to 12.5kc/s. Increasing the pass band of the a.m. receiver up to 0.5Mc/s certainly gave less difference in the response of the two systems to impulsive noise, but this can hardly be taken as favourable towards a.m. If narrow-band a.m. were to be adopted the listener could say goodbye to either high-quality reproduction or efficient noise suppression, or more likely both, in urban areas. As a town dweller myself, surrounded by all manner of impulsive noise generators, I confess to writing with some feeling.

Turning now, perforce, to the economic angle of this controversy, we are all sadly aware in these islands that to expect to have the best for our own consumption is an expectation regarded as near treason in some quarters. In contrast to such ideas, I would give it as my opinion that this is one best we cannot afford to do without. If we are to continue to export our radio equipment we must supply the best. If we have no home market to create the initial demand and thus permit the low-cost benefits of a reasonable degree of mass production to be built up, we shall certainly be unable to compete in world markets, and so far as I am aware this is the only country where f.m. has not been decided upon for v.h.f. broadcasting.

If it is argued that a.m. should be adopted only as a short-term policy, I feel it is pertinent to ask with some suspicion what is a short term? F H. BEAUMONT.

R. N. Fitton, Ltd., Brighouse, Yorks.

* This paper, and the discussion which followed it, was as much concerned with economics as engineering.—ED.

Legitimizing the "Puff"

I QUITE agree with A. C. Kay (August issue) that the present capacitance units could be improved, but I am stricken with horror at his proposed remedy of making the picofarad (renamed) the "practical" unit. If we accept the principle of an integrated system of units, the farad must be determined by the definitions of volt and coulomb. We have suffered and cursed for years under the triplicated burden of e.m.us, e.s.us, and "practical" units, and now at last, 50 years A.G. (After Giorgi) hope dawns. Without personal malice I wish Mr. Kay's proposed *extra* unit the worst of luck!

The problem has been wrongly appreciated. The size of the basic unit is not important if the system of submultiples is adequate. The solution is simple and direct: we need a metric prefix for 10^{-9}, and it is absurd that, needing it, we cannot provide ourselves with one. While this is not really a field for rugged individualism no official extensions to the metric prefixes were provided for the badly needed 10^{9} and 10^{-12} so the Americans (having 10^{9} of everything) coined "bega" by analogy with "mega," while Campbell suggested "pico" (perhaps from Ital. "poco") which was gratefully seized upon (and is now better known than the official "myriz" for 10^{4}).

If we are to coin a metric prefix we may as well engineer it while we are at it. It should (i) have a distinctive initial letter for abbreviation (be warned by mega, milli, micro), (ii) two syllables at most for "wieldiness," (iii) be formed from a root suggesting its meaning in some major language, (iv) occur at intervals of 10^{3} since this enables the common accuracy of three significant figures to be written without added noughts to position the decimal point (redundant as information). That smaller intervals are not needed is shown by the disuse of deci, deka, hecto, and myria.

The International Metric Convention does not concern itself with nomenclature, and we cannot very well revive the French revolutionary government. So it is up to us, and encouraged by Campbell's success and with due humility, may I suggest for 10^{-9} farad—LILLIFARAD; of obvious origin, fulfilling the specification above, and in the modern humorous tradition of electronics (sanatron!) 1,000pf or 0.001μF then becomes 1 lillifarad or 1LF.

This adds to the list of metric-decimal prefixes and thus serves the whole physical system of units, electrical or otherwise, whereas Mr. Kay's suggestion only tackles the local problem of noughts on a capacitor, doing in the process great damage to the integrated system of units.

Prestwich, Manchester. V. MAYES.

[The prefix "nano-" (abbreviation n) for 10^{-9} has some currency on the Continent.—ED.]

Nomenclature

I HAVE read with interest Mr. Puckle's letter (your August issue) about the flip-flops. I did not know who had invented this term which I liked (and adopted) as soon as I heard of it, because it is so self-evident.

The Electronics Glossary and Symbols Panel of the Central Radio Bureau, which looks after the standardization of symbols and technical terms in the fighting services, has anticipated Mr. Puckle's wants. Their recommendations are given in the Interservices Glossary of Terms used in Telecommunications and Electronic Engineering.

Relaxation circuit.—A circuit arrangement, usually of

valves, reactances and resistors, which has two states or conditions, *one*, *both*, or *neither* of which may be stable. The transient voltage produced by passing from one to the other, or the voltage in a state of rest, can be used in other circuits.

Stable trigger circuit (Alternative: Trigger circuit).—A relaxation circuit which has *two* stable conditions, and can be made to pass very rapidly from one to the other by applying a suitable triggering pulse or signal. The Eccles-Jordan circuit is an example of a trigger circuit.

Flip-flop circuit.—Kipp relay [deprecated]: One-shot multivibrator [deprecated].—A relaxation circuit having *one* stable and one unstable condition. By applying a triggering pulse or signal it may be made to pass very rapidly into the unstable condition whence, after a certain time interval, it automatically returns to the stable condition.

Multivibrator.—A relaxation circuit which has *two* unstable conditions and successively passes from one to the other as long as it is operating. The Abraham-Bloch multivibrator is an example.

It might be advisable to add "two-state" to the term "stable trigger," if "more-than-two-state" circuits become more common. L. BAINBRIDGE-BELL.

Haslemere, Surrey.

"Bass Without Big Baffles"

BEFORE correspondence on this subject is closed perhaps you would allow me to make a final suggestion to those wishing to experiment with my amplifier.

The upper limit of the range of frequencies subjected to harmonic distortion by V_3 is dependent on the choice of capacity for C_4. Too liberal a harmonic content would undoubtedly have resulted in reports claiming that *unpleasant* distortion products from V_3 were audible in the final output. In the April issue I specified a fixed value of 0.1μF for C_4—verging on the safe side.

However, considerable advantage can be gained by varying the value of C_4 to suit the size of baffle and speaker in use. The smaller the baffle the wider should be the range of harmonics introduced. Examples of baffle frontage areas with suitable values for C_4 are as follows:—

Areas of 1 sq ft or less; 0.03μF.
Between 1 sq ft and 4 sq ft; 0.05μF.
In excess of 4 sq ft; 0.1μF.

In each case (with the middle control turned well down) the advent of any unpleasant products in the output should be offset by an increase in capacity of C_4.

The "bass control" of the amplifier alters the level of low frequencies passing through the *linear* channel only, and is thus somewhat limited in its range of effect. Some readers may prefer to substitute a control switching in various values of C_4 instead. K. A. EXLEY.

Leeds, 6.

Screened Valves

I DEPLORE the tendency of British manufacturers of American-type valves to relegate the metal-shelled type of valve to the ranks of the "replacement type." This means that manufacture of such valves in this country will soon cease.

The advantage of the metal type of valve is, of course, that, when used in r.f. applications, no screening can is necessary; indeed the screening is far better than that which can be achieved by the use of external screens.

Scunthorpe, Lincs. KEITH R. BROOK.

Crystal Menace?

IF crystal receivers become popular as antidotes to power cuts, I foresee another source of interference to short-wave reception All such sets, including the modern version described in your September issue, will radiate harmonics of the station to which they are tuned.

A partial remedy, of course, is either to earth or disconnect the aerial when the set is not actually in operation. It might also be worth while—and practicable—to design the two-circuit tuner so as to minimize the radiation of harmonics. C. KIDD

London, S.W.

Jointing Aluminium

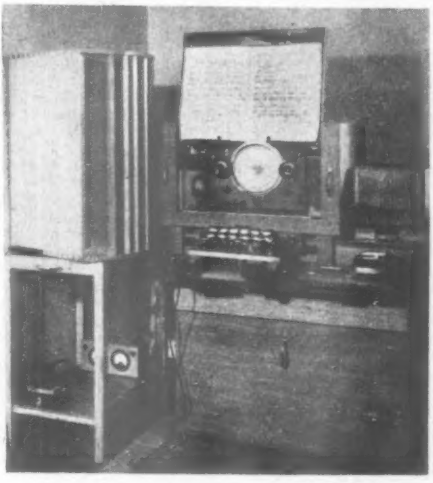
I HAVE noted with interest the article in the May issue of your Journal but must protest at its casual dismissal of the method using a solder containing 90 per cent tin and 10 per cent zinc. Admittedly, when this process is used, the metal has to be cleaned carefully but not so carefully as is required for cold welding. Furthermore, provided the surface to be tinned is brushed under the surface of the molten metal, the results obtained are perfectly satisfactory and quite equal to any that may be obtained by the use of an ultrasonic soldering iron.

The principles in so far as disturbance of the metal surface is concerned and the temperatures required are substantially the same for both methods and both have their own particular application.

The ultrasonic method is obviously to be preferred for thin foils and fine wires where mechanical abrasion methods cannot be employed. However, completely satisfactory results have been obtained throughout the electrical industry all over the world by the wire brushing technique on aluminium-sheathed cables, where it is employed for tinning the sheath prior to joint wiping. The undoubted success and acceptance of this method clearly show the disparaging remarks of your contributor to be inadmissible. P. A. RAINE.

Johnson & Phillips, Ltd., London, S.E.7.

MANUAL EXPANSION



LISTENER PARTICIPATION.—A correspondent, Major F. Le Heup Salmon, has sent us this illustration of his receiving equipment which, by the use of a row of keys below the receiver, provides a simple means of volume expansion.

Exhibition Audio Convention

Points Raised in the Lectures and Discussions

TO those interested in electro-acoustics the list of subjects and authors (see p. 373 of our last issue) was in itself sufficient augury for the success of the audio engineering session of the British Institution of Radio Engineers' 1951 Convention. This session was held on 4th—6th September at Earls Court in conjunction with the National Radio Exhibition.

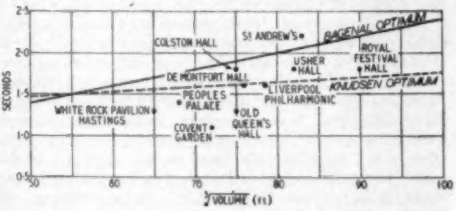
The chairman, H. J. Leak, in his opening remarks pointed out that in fifteen lectures it would be possible only to touch the fringe of so wide a subject and that in choosing topics for discussion the guiding principle had been to concentrate on subjects which were still matters of controversy or of which our knowledge was less secure—for example, electro-acoustic transducers, auditorium acoustics and, at the foundation of all matters relating to sound, the mechanism of hearing.

A lucid description of the anatomy of the ear, illustrated by models and microscopic sections, was given by Dr. T. S. Littler, who also outlined the present state of our knowledge of the nerve processes which form an essential part of auditory perception. The "volley" theory which presupposes the use of multiple nerves, "firing" in succession, to overcome the known frequency limitation of single fibres, and the "place" theory which rests on experimental evidence that different frequencies stimulate different regions of the basilar membrane, were described and discussed. The general opinion seemed to be that the brain does not rely on any one system of nerve impulses, but on a combination of all, and that their relative importance varies with the individual.

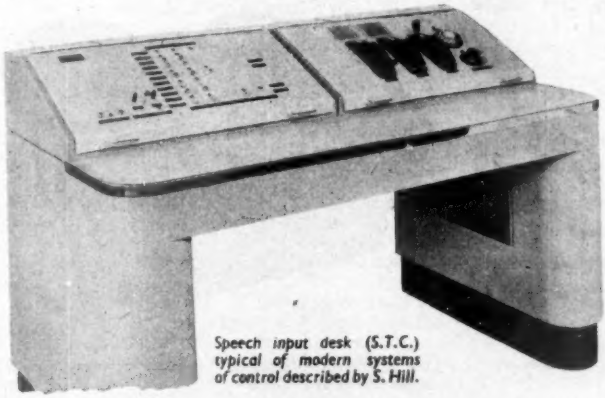
It was pointed out by J. Moir and J. A. Leslie in their paper on stereophonic reproduction that the ear can discriminate against reflected sound and concentrate on the direct sound, a faculty which preserves the sense of direction indoors and makes stereophony possible. This inhibitory mechanism may have some relation to the variations in rate of firing of a nerve as a function of time after the application of a stimulus —a point which was referred to by Dr. Littler. It was also pointed out that the directivity of the ear under stereophonic conditions gave the effect of a 12db increase in apparent signal/noise ratio as well as a greater tolerance for reduced bandwidth in the reproducing system. One contributor to the discussion also claimed for stereophony the equivalent of a reduction in intermodulation distortion.

Reverberation time of the Royal Festival Hall as a function of frequency. (P. H. Parkin)

Reverberation times, at 500c/s with full audience, of some representative British concert Halls. (P. H. Parkin)



The fact that reflections with small time delays do not destroy the sense of direction (the "Haas effect") is also made use of in the design of auditoria, as was mentioned by P. H. Parkin when dealing with the acoustics of the Royal Festival Hall. An important feature of the design is the large reflector over the orchestra which increases the apparent direct sound intensity and contributes to the excellent definition for which the Hall is noted. Mr. Parkin described the measurements made during and after the building of the Hall and showed curves of the variation of reverberation with frequency and the average reverberation time in relation to other well-known concert halls. Pulse methods of testing, although providing valuable information, involved an enormous volume of work in measurement and interpretation, and in support of this a series of pulse echoes taken at frequency intervals of a few cycles were shown which exhibited wide differences in general character. When



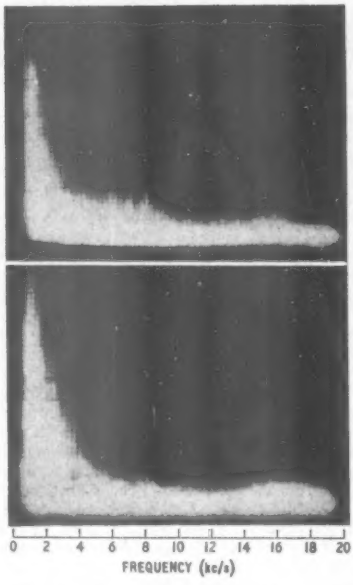
Speech input desk (S.T.C.) typical of modern systems of control described by S. Hill.

designing a new hall one had to decide on a general average reverberation time as a basis for calculating the amount of absorbent material to be used.

The problems of high-quality reproduction in small rooms were discussed by P. J. Walker who showed that reflection from the walls could be arranged to simulate a wavefront arriving from a virtual image of the sound source outside the room, sufficient directivity in the forward radiation from the loudspeaker being retained to give the impression of a smaller and nearer source over the band of medium frequencies predominating in speech. J. S. Youngmark, who spoke on the problems of loudspeaker cabinet design, demonstrated a method of producing a similar effect by using single and multiple units according to the nature of the programme. Discussion on these papers raised two interesting points—the danger of exciting all eigentones of a room when a loudspeaker is sited in one corner, and the desirability of large volume in cabinets of the "bass reflex" type in order to reduce the "Q" at the low-frequency acoustic resonance. Figures quoted by one speaker gave a Q of 120 for the case of one cabinet of 2 cubic feet volume compared with 27 for 10 cu. ft.

Measurements on loudspeakers and the relation of subjective to objective tests were dealt with by F. H. Brittain who advocated the use of loudness/pitch curves instead of the more usual intensity/frequency characteristic. In the discussion which followed it was suggested that complete correlation between subjective and objective tests presupposed the existence of a "standard ear" and as this does not in fact exist, any relationship between hearing and measurement must always be variable. At the end of the lecture Mr. Brittain demonstrated, by means of loudspeaker reproduction of tape recordings of his own voice, adjusted by means of a sound level meter, the incongruities which result from reproducing speech at levels differing from the original.

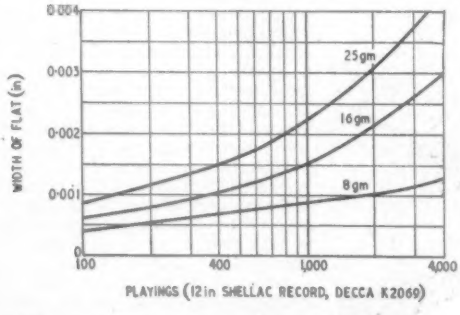
The importance of competent level monitoring in the control room was also one of the points raised by S. Hill in his paper on speech input equipment for broadcast transmitters. A lively discussion developed on the relative merits of peak programme meters as used in Europe and the V.U. meter favoured in the U.S.A. It was thought that the peak programme meter was best, in that it showed what was actually happening in the circuit, but that the V.U. meter had distinct advantages in large systems, as it was less troubled by phase delays, and gave similar



Spectra of a.f. energy, including noise, taken over periods of 1½-2 minutes on Decca standard shellac records; (top) second side of "Danse Macabre", (bottom) first side of Beethoven's 5th Symphony. (E. D. Parchment and N. C. Mordaunt)

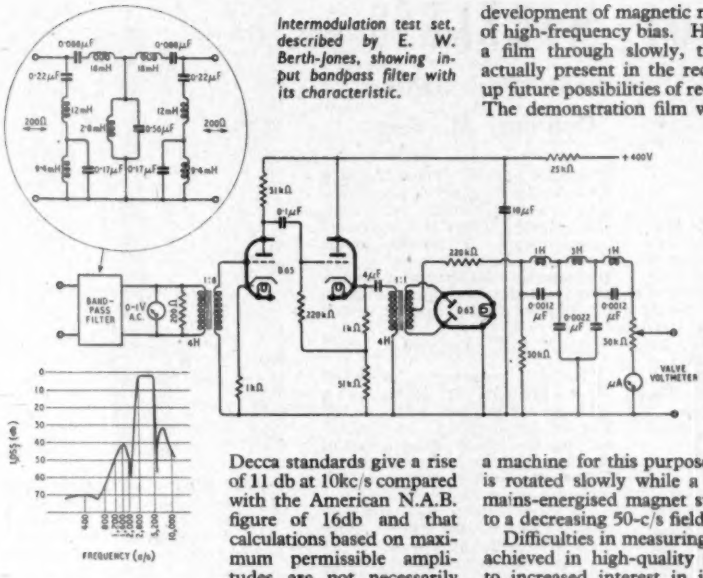
indications at the ends of a long line. For this reason it would gain ground first in telecommunications and might be expected to invade broadcast systems at a later date.

Recorded sound was represented by two papers on magnetic recording and one on microgroove disc recording. In answer to criticisms that pre-emphasis in microgroove recording might offset any advantages over standard 78-r.p.m. constant-velocity characteristics which might otherwise be obtained in the matter of tracing distortion, it was pointed out by E. D. Parchment and N. C. Mordaunt that present



Wear on 0.0027-in radius sapphire stylus with different downward pressures. (S. Kelly)

British Acoustic "Ferrosonic" portable magnetic recorder demonstrated by Dr. Kolb.



Intermodulation test set, described by E. W. Berth-Jones, showing input bandpass filter with its characteristic.

Decca standards give a rise of 11 db at 10kc/s compared with the American N.A.B. figure of 16db and that calculations based on maximum permissible amplitudes are not necessarily valid for actual recording conditions. In support of this latter point they have recorded the energy spectra (including noise) of the louder parts of typical records which indicate the relatively small energy content at high frequencies.

Analytical methods, using equivalent electrical circuits as analogue computors, were described by K. R. McLachlan and R. Yorke for solving some of the first-order design problems of loudspeakers and pickups. Calculations of polar and torsional vibrations in tone arms have been investigated experimentally with the aid of strain gauges attached to the surface of the arm, and have shown good correlation. Problems of needle-record contact and stylus wear were included by S. Kelly in his paper on piezoelectric pick-ups. On the subject of stylus wear, Mr. Kelly underlined the variability of sapphire, which he attributed to variations in the angles between the "stress surfaces" in the synthetically-grown sapphire "boule" and the axis of the finished stylus. Typical wear curves were shown to emphasise the importance of reducing vertical pressure as far as possible.

One of the more important applications of magnetic recording is in the film industry, where its convenience "on location" has been already proved. An interesting portable recorder using ¼in. tape and synchronized by a picture frame pulse originating in the camera was described by N. Leevers. In the conventional capstan drive, slip often occurs because the capstan becomes polished and the drive is mainly indirect via the margins of the rubber pressure roller and thence to the polished side of the tape. This has been overcome by reversing the tape to bring the oxide coating in contact with the rubber.

In the magnetic sound film system demonstrated by Dr. Kolb, standard perforated 35 mm. film base is used, and slip cannot arise, though more care must be taken in the design of mechanical filters in the drive. Dr. Kolb gave an excellent résumé of the development of magnetic recording and of the theories of high-frequency bias. He demonstrated, by running a film through slowly, that the supersonic bias is actually present in the recording, a fact which opens up future possibilities of recording at video frequencies. The demonstration film was recorded at 50kc/s with a 0.008in gap to emphasise that the rapidity of decrease of field on leaving the gap rather than the gap width is the deciding factor when recording at high frequencies.

Traces of supersonic modulation could be detected in film erased with a supersonic field. Dr. Kolb favoured the use of a.c. mains for erasure which gave a 10db reduction in residual level. He described a machine for this purpose in which a full reel of tape is rotated slowly while a translatory movement of a mains-energised magnet subjects each part of the reel to a decreasing 50-c/s field.

Difficulties in measuring distortions at the low levels achieved in high-quality magnetic recording has led to increased interest in intermodulation methods of measurement. E. W. Berth-Jones gave details of an intermodulation test set capable of d.c. calibration. The design is based on a comprehensive survey of all significant intermodulation products and takes into account the importance of correct rectifier conditions. Not the least valuable lesson to be learnt from Mr. Berth-Jones' paper is that percentage intermodulation figures are meaningless without a clear statement of the conditions under which they are obtained.

Although in distortion measurement one seldom gets as far as, say, the seventh or ninth harmonics, it was interesting to learn from L. E. A. Bourn's paper on "electrophonic" organs that harmonics up to the 32nd are significant and are included when synthesizing the tone of some of the traditional organ stops. In small two-manual instruments use is now made of formant tone generators with complex waveforms in preference to the original method of combining pure tones. It is interesting to learn that phase, as well as relative amplitude of harmonics, is significant and is taken into account when developing the waveform of the generating elements. When stops are mixed, some drift of phase is necessary to simulate the "vitality" of a pipe organ and to this end the generators are belt-driven to avoid too constant a phase relationship between the ranks.

After describing the development of the modern electronic instrument from early beginnings, a short recital was given by Mr. Taylor of the John Compton Organ Company, who ably demonstrated the quality and range of traditional as well as modern tone now available to the organist.

In this brief résumé of the proceedings we have been able to select at random only a few of the many interesting matters which were demonstrated and discussed. We understood, however, that a transcript of the discussions, which were recorded throughout, will be published, together with the original papers, in the Journal of the Brit.I.R.E.

WORLD OF WIRELESS

Notes and News ◆ Radio Personalities
The Industry ◆ October Meetings

German Television

WESTERN Germany now has a television station. On September 3rd regular transmissions were started from the station recently installed in one of the wartime anti-aircraft (flak) towers in the centre of Hamburg. Operated by the Nordwestdeutscher Rundfunk, the German-made transmitter employs the standards proposed by the C.C.I.R.—625 lines, 50 frames interlaced, negative modulation and f.m. sound. The 1-kW vision transmitter operates on 189.25Mc/s and the 0.3-kW sound set on 195.75Mc/s.

Radio Shows

WITHIN a few days of the closing of the 18th National Radio Show at Earls Court, the R.I.C. announced that it would hold an exhibition next Spring in the City Hall, Manchester. The provisional dates are April 23rd to May 3rd. The next London show is planned for September, 1952, at Earls Court.

The attendance of 232,752 at Earls Court included 1,818 overseas visitors. The figures for the last two London shows were: 1947, 443,433; 1949, 395,465.

Television Convention

AS already announced, the Radio Section of the I.E.E. plans to hold a television convention from April 28th to May 3rd next year.

The whole field of television will be covered in nine sessions, each of approximately two hours' duration. The titles of the sessions, at each of which a survey paper and a number of supporting papers will be discussed, are:—Programme Origination; Point-to-Point Transmission; Broadcasting Stations; Propagation; Receiving Equipment (2 sessions); Non-Broadcasting Applications; and System Aspects.

Grad.Inst.P.

SINCE the introduction of this grade of membership of the Institute of Physics in 1949, some 400 applicants holding a recognized degree or other qualification in physics have been elected graduates. Now the Institute has introduced an examination by which those not holding a recognized university degree may become graduates. The exam will consist of three papers and a practical exam in physics, two mathematics papers and a paper on statistics or advanced, mathematical or applied physics. Those choosing the latter have a choice of electronics, acoustics, high-vacuum technology, spectroscopy, X-rays or temperature measurement. A booklet giving regulations and syllabuses for the graduateship examination is obtainable from the Institute of Physics, 47, Belgrave Square, London, S.W.1.

New B.B.C. Stations

THREE temporary low-power transmitters at Ramsgate, Hastings and Brighton were brought into use by the B.B.C. on September 16th to improve the reception of the Home Service in those localities. These are the first of twelve such stations promised by the P.M.G.

All three stations will ultimately have a power of 2kW but at present they are somewhat lower. The Ramsgate transmitter will radiate on 1484kc/s, and Hastings and Brighton on 1457kc/s.

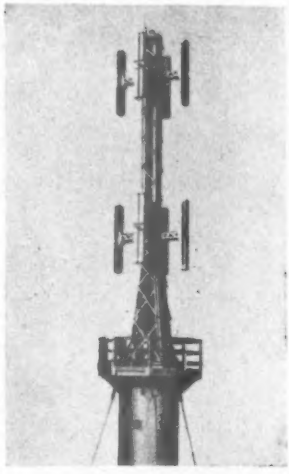
Holme Moss

PREPARATORY to the opening of the northern television station at Holme Moss, near Huddersfield, on October 12th by the Postmaster General, test transmissions on full power (45-kW vision and 12-kW sound) have been taking place daily since September 3rd. Prior to this date test transmissions had been conducted with the standby equipment (5-kW vision, 2-kW sound). The station operates on Channel 2 (vision, 51.75Mc/s; sound, 48.25Mc/s).

Business Radio

THE recent statement by the P.M.G. regarding the development of mobile v.h.f. radio-telephone service in this country makes it opportune to draw attention to the booklet being prepared by the Radio Communication and Electronic Engineering Association for the guidance of potential users of the service. It explains the uses of the service and gives information on the installation of equipment and licensing procedure. Enquiries for copies, which will be available shortly, should be sent to the R.C.E.E.A., 59, Russell Square, London, W.C.1.

There have been a number of outstanding successes in the use of this service in the past few months. Among them the *Daily Mail* cross-channel swimming contest in which 26 Pye walkie-talkies were used, 20 of them in the boats accompanying the swimmers.



HOLME MOSS.—The combined sound and vision array which, at the top of the 750-ft mast, is 2,500 ft above sea level. This photograph is taken from a lavishly illustrated booklet on television equipment issued by Marconi's.

Two channels were used (86.675 and 86.375Mc/s), providing separate frequencies for the accompanying boats and the subsidiary control launches. Marconi equipment was installed on the main control vessel for Press reports.

The maintenance of one of the largest main drainage systems in the world, serving an area in West Middlesex of 160 sq miles, has been made safer and more efficient by the introduction of a radio-telephone system whereby the three maintenance vans can keep in touch with headquarters. The 15-20-watt G.E.C. equipment operates on 85.375 and 71.875Mc/s.

Measuring Instruments

IN order to bring into closer relationship three associations whose interests include matters relating to the development and production of measuring instruments for radio and radar, a Joint Advisory Committee on Radio Communication and Radar Measuring Instruments has been formed.

Membership is open to any member of the three associations—Radio Communication & Electronic Engineering Association, Radio & Electronic Component Manufacturers' Federation and Scientific Instrument Manufacturers' Association—who is concerned with developing or making measuring instruments.

The joint committee will deal with both technical and commercial questions. The Committee will be administered from the R.C.E.E.A. offices.

Marine Radio

IN view of the present congested state of the spectrum, the G.P.O. has decided, after consultation with the Ministry of Transport and other marine interests, to issue revised specifications covering the technical requirements to which ships' radio equipment should conform. Revised specifications covering the various types of installation are therefore being issued. The first, "Radio for Merchant Ships: Performance Specification for an Emergency Receiver (with Loudspeaker-Watching Facility)" has been published by H.M.S.O., price 6d.

Hardy Annual

DURING the currency of this issue the *Wireless World* Diary for 1952 will make its appearance at newsagents, stationers, etc. In addition to the week-at-an-opening diary section, there are 80 pages of information and data ranging from postal rates to formulæ. The Diary, now in its 34th year of publication, is available in Morocco leather at 6s 1½d or rexine at 4s 3½d (including Purchase Tax).

PERSONALITIES

Sir Archibald Gill, who has been Engineer-in-Chief at the Post Office since 1947, is retiring on October 1st. He is succeeded by **Dr. W. G. Radley,** C.B.E., M.I.E.E., who entered the Post

DR. W. G. RADLEY, C.B.E.

Office Engineering Dept. as a temporary inspector in 1920. Prior to his appointment as Deputy E.-in-C. in 1949, he was for five years Controller of Research. He was chairman of the committee formed to advise the Medical Research Council on the design of hearing aids.

Sir Arthur Fleming, C.B.E., D.Eng., relinquished his executive duties as Director of Research and Education in Metropolitan-Vickers on his appointment to a similar post with the parent company, Associated Electrical Industries. He has been with Metrovick since 1902. He was recently appointed a member of the Government's reconstituted Technical Personnel Committee, of which Lord Hankey is chairman. Sir Arthur is succeeded by **Dr. C. Dannatt,** O.B.E., M.I.E.E., who is also appointed asst. managing director.

Col. J. Reading, M.B.E., B.Sc.(Eng.), M.I.E.E., the new G.P.O. Assistant Engineer-in-Chief, entered the Equipment Branch of the Engineering Department in 1925. From 1935 to the outbreak of war, Colonel Reading was Managing Editor of the *Post Office Electrical Engineers' Journal*, and has been secretary of the Institution of Post Office Electrical Engineers since 1935. After serving in various theatres of war from 1939 he was eventually appointed Chief Signals Officer, War Office Signals. He returned to the Post Office in 1946.

F. C. McLean, B.Sc., M.B.E., who was appointed head of the B.B.C.'s Engineering Projects Group towards the end of last year, has, in view of the prolonged illness of **H. L. Kirke** (Asst. Chief Engineer), been appointed Acting Assistant Chief Engineer. He will co-ordinate and direct the technical work of the Research, Designs, Equipment, and Planning and Installation Departments.

R. C. Patrick, Assoc. I.E.E., who joined the Research Department of the B.B.C. in 1925, has been appointed Assistant Superintendent Engineer (Recording). During World War II he was Assistant Engineer-in-Charge at the B.B.C.'s emergency headquarters.

G. Stannard, A.M.I.E.E., who has been appointed B.B.C. Assistant Superintendent Engineer (Lines) in succession to **W. G. Edwards,** who has retired, joined the Operations and Maintenance Department of the Corporation in 1932. Since 1947 he has been engaged on the design of equipment associated with the G.P.O. line networks that link the studio centres and transmitting stations.

S. Stansbridge, who has retired after more than 45 years' service with the Marconi International Marine Communication Co., had been in control of the operating and traffic activities of the company since 1928. He joined the staff at the original wireless station at Seaforth, near Liverpool. From 1908 until 1916 he was an operator in many well-known vessels. In his retirement he will act as the company's representative on the employers' side of the Radio Officers' Panel of the National Maritime Board, and various other committees.

C. L. G. Fairfield, M.A., A.M.I.E.E., who joined the Mullard Organization in 1947 as assistant to the directors on technical matters, has been appointed manager of the Valve Division of Mullard, Ltd.

IN BRIEF

Receiving Licences.—Approximately 12,434,900 broadcast receiving licences, including 915,200 for television, were current in Great Britain and Northern Ireland at the end of July. The monthly increase in television licences (18,200) was the lowest in any month since July last year.

Amateur Radio Exhibition.—The fifth exhibition of amateur radio equipment, organized by the Radio Society of Great Britain, will be held at the Royal Hotel, London, W.C.1, from November 28th to December 1st.

B.V.A. Officers.—The British Radio Valve Manufacturers' Association—one of the four constituent bodies of the Radio Industry Council—has re-elected J. W. Ridgeway (Ediswan) chairman for the tenth term of office, and G. A. Marriott vice-chairman for the third time.

Hearing Aid Reliability.—Valves, which had been expected to be the biggest source of trouble in the Medresco hearing aid, have proved to be "by far the most robust and reliable link," according to the writer of an article on the Medresco in the August issue of the Post Office *Telecommunications Journal*. The cords, however, have proved to be the most troublesome.

COL. J. READING, M.B.E., B.Sc.(Eng.) (See centre column).

Coast-to-Coast Television is now possible in the United States with the completion of a chain of 107 radio relay towers erected by the American Telephone and Telegraph Co. Four-storey concrete towers each 125 feet high and carrying four rectangular horn-type aerials are spaced at approximately 30-mile intervals.

Brit.I.R.E. Premiums.—The senior award of the Brit.I.R.E., the Clerk-Maxwell Premium, for the most outstanding paper published in the Institution's *Journal* during the year 1950, has been given to D. W. Heightman (English Electric) for his paper on "The Propagation of Metric Waves Beyond Optical Range." Rudolph Kompfner, Dipl.Ing., (The Clarendon Laboratory, Oxford), receives the Heinrich Hertz Premium for his paper "On the Operation of the Travelling Wave Tube at Low Level." The Louis Sterling Premium is presented to J. E. B. Jacob, B.Sc., (Cinema Television), for his paper on "High Performance Television Monitors," and S. W. Punnett, B.Sc., (University College, Southampton), receives the Dr. Norman Partridge Memorial Award for his paper, "Audio Frequency Selective Amplifiers."

Ionosphere Lectures.—A course of six lectures on "Radio Wave Propagation and the Ionosphere" will be given by L. Prechner, B.Sc.(Eng.), of the Engineering Division, B.B.C., at the Polytechnic, Regent Street, London, W.1, on Tuesdays from 6.30 to 8.0 commencing on October 16th. The recommended reading is the *Wireless World* book "Short-Wave Radio and the Ionosphere" by T. W. Bennington. The fee is 15/-.

Educational Opportunities.—In addition to the prospectuses covering both day and evening courses in radio and allied subjects to which we referred last month, we have received details of similar courses from the Northern Polytechnic, Holloway, London, N.7; Norwood Technical College, London, S.E.27; Manchester and District

Advisory Council for Further Education, and the School of Engineering, Crawford Street, Burnbank, Lanark. We have also received additional material from the South-East London Technical College, Lewisham Way, London, S.E.4, regarding an eight-week full-time course in electrical technology and electronics which begins on October 15th.

Amateur Radio Courses.—Although by the time this issue appears the courses will have commenced, readers in the London area may like to know of evening classes which are being held at the Ilford Literary Institute, Cranbrook Road, Ilford, Essex. On Mondays there are courses covering amateur television (six months) and morse (3-6 months); Tuesdays a six-months' amateur radio refresher course; and on Wednesdays an eight-months' course for the Radio Amateurs' Examination. The courses, for each of which the fee is 7s 6d, are organized by the East London R.S.G.B. Group in conjunction with the Essex County Council.

Television Training Centres are being provided by the G.E.C. in Glasgow and Edinburgh in anticipation of the opening of the Scottish station at Kirk O' Shotts which lies midway between the two cities. The Glasgow centre has been in operation for some weeks and closes at the end of September; but courses open at Magnet House, 8, George Street, Edinburgh, on October 1st. Five courses, each lasting a week, will be provided.

Waveguide Symbols.—Supplement No. 2 (1951) to British Standard 530:1948 is entitled "Graphical Symbols used in Waveguide Technique" and is supplementary to the general list of graphical symbols used in telecommunications, issued by the British Standards Institution. The symbols are broadly of two kinds: for diagrams of actual apparatus the waveguide is represented by a pair of lines, and for theoretical diagrams by a single line. The supplement is issued by the British Standards Institution, 24, Victoria Street, London, S.W.1, price 3s post free.

Piezo-electric Terms.—The fifth supplement to the "Glossary of Terms Used in Telecommunication" (BS204) covers terms used in the preparation of piezo-electric crystal units—they are engineering rather than crystallographic terms. The supplement is obtainable from the British Standards Institution, price 1s.

Siting Precautions necessary when installing radar in merchant ships are outlined in the Ministry of Transport Notice M.352 which replaces M.317 of 1948. Copies are obtainable gratis from the M.o.T. Marine (Navigational Aids) Division, Berkeley Square House, London, W.1.

Standards Yearbook.—According to the 1951 edition of the British Standards Institution Yearbook, there were some 35 Standards relating to radio, radar and electronic equipment current at the end of 1950. This 400-page book, which costs 7s 6d, post free, gives a brief description of each of the current Standards and an up-to-date record of the work of the Institution. Standards are listed numerically and there is also a subject index which includes details of a number of codes of practice.

INDUSTRIAL NEWS

Television Exports.—Bush tunable television receivers, Type TV24, modified for reception of the American television channels 2, 3, 4, 5 and 6 (54-72 and 76-88Mc/s) have been exported by M. Falk & Co. to Brazil. The receivers, about 100, have also been modified for f.m. sound. The leader of the Uruguayan delegation to the recent UNESCO Conference in Paris spent a fortnight in August studying the organization of the television service in this country and visited the factories of E.M.I. and Marconi's. Press delegations from Chile and Spain recently visited the E.M.I. factory.

Marconi gear, operated by a Marconi Radio Officer, was carried on the English Electric Canberra during its recent transatlantic record-breaking flight.

Ferranti Distance Measuring Equipment (D.M.E.) was carried by the De Havilland Comet during its recent proving trials on the Middle East route. So that the Comet will have this short-range radar navigational aid at each stopping point, ground equipment has recently been installed by Ferranti at Rome and Cairo. A D.M.E. beacon is already in use at London Airport.

Egypt has ordered from Marconi's a medium-wave 100-kW air-cooled transmitter for its broadcasting service as well as the 100-kW short-wave station previously mentioned. The Government has also ordered a 3-kW medium-frequency beacon transmitter for an airport.

South American Television.—The installation which Marconi's are supplying for the introduction of a television service in Bogota, Colombia, will consist of a 5-kW vision transmitter, 3-kW sound transmitter, studio equipment including telecine gear and an O.B. vehicle.

Tenders are being sought by the City Electric Light Co., Brisbane, N.S.W., for the supply of equipment for five fixed stations and 30 mobile stations, with ancillary gear, for the extension of the company's two-way radio-telephone communication system. Further particulars are available from the Commercial Relations and Exports Department, Board of Trade, Room 1080, Thames House North, Millbank, London, S.W.1, quoting ref. CRE (IB) 68387/51.

Nickel Plating.—The recent Government Order forbidding the use of nickel for plating purposes, except in certain armament requirements, has made it opportune for Metal Processes, Ltd., to bring to our notice their Niklit finish which by simple immersion imparts an imitation nickel-plate finish.

CONTROL ROOM, EARLS COURT.—Earl Mountbatten, who opened the Radio Show, is seen here inspecting the sound distribution equipment installed for the R.I.C. by Standard Telephones & Cables. He is in conversation with R. W. Addie, chairman of the Exhibition Technical Committee.

MEETINGS

Institution of Electrical Engineers

Inaugural address of Sir John Hacking, President, on October 11th.

Radio Section.—Address of D. C. Espley, O.B.E., D.Eng., chairman, on October 17th.

Discussion on "The Social Implications of Television" to be opened by F. H. Townsend on October 29th.

Above meetings will be held at 5.30 at Savoy Place, London, W.C.2.

British Institution of Radio Engineers

London Section.—"Acoustics in Relation to Radio Engineering" by E. G. Richardson, B.A., Ph.D., D.Sc., at 6.30 on October 11th, at the London School of Hygiene & Tropical Medicine, Keppel Street, London, W.C.1.

Scottish Section.—Dr. Richardson's paper will also be read at 7.0 on October 4th in Edinburgh; and at 7.0 on October 5th at the Institute of Engineers and Shipbuilders, Glasgow.

Television Society

"A Line Strobe Monitor for Measuring and Investigating Television Waveforms" by E. Davies (Marconi's) at 7.0 on October 26th.

Engineering Group.—"P.O. Cable Circuits for the O.B. Television Service" by B. H. Moore (P.O. Engineering Dept.) at 7.0 on October 11th.

Both meetings will be held at the Cinema Exhibitors' Association, 164, Shaftesbury Avenue, London, W.C.1.

Amplified Automatic Gain Control

Simple Circuit Using High-slope Pentodes with Suppressor-grid Injection

By S. W. AMOS,* B.Sc. (Hons) and G. G. JOHNSTONE,* B.Sc. (Hons)

THIS article describes an amplified automatic gain control circuit which can be embodied in a t.r.f. or superheterodyne receiver and is no more complicated than circuits currently used for non-amplified a.g.c.; no additional valves or negative h.t. supply are required. An advantage of the circuit is that the controlled valves may be high-slope pentodes giving higher gain than is available from the variable-mu pentodes used in conventional a.g.c. circuits. The performance obtainable from the suggested circuit can be illustrated by the following measurements made on a t.r.f. receiver with a single controlled valve. As the input was increased from 100 μV to 0.3 volt, the output increased by less than 2 db; in a typical 4-valve superhet with two controlled stages but non-amplified a.g.c. the output increases by approximately 15 db for the same range of input signal amplitude.

The circuit to be described embodies suppressor-grid injection of the control voltage. The application of a negative bias to the suppressor grid of a pentode produces markedly different effects from a negative potential applied to the control grid. The effect of varying the control-grid potential is to vary the total (i.e. anode + screen) current and the curve of total current plotted against control-grid potential is similar to that of a triode. The effect of varying the suppressor-grid potential however is to vary the ratio in which the total current is divided between the screen and the anode. This is illustrated in Fig. 1, which shows that increase in negative suppressor bias decreases the anode current and increases the screen current, and provided the screen-cathode potential is maintained constant the total current is substantially independent of suppressor-grid potential. By negatively biasing the suppressor grid the anode current is reduced but—more important in the circuit to be described—the change in anode current per volt change in grid potential is also reduced in the same ratio; in other words the mutual conductance of the pentode is reduced by application of negative bias to the suppressor grid.

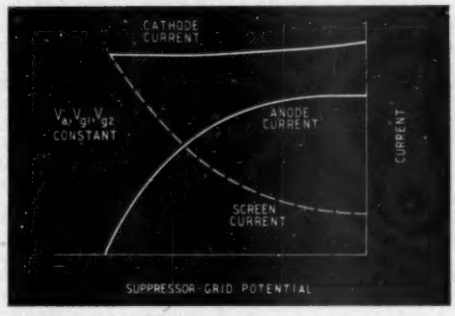


Fig. 1. Typical curves illustrating variation of screen and anode current with suppressor-grid potential.

Thus the application of negative bias to the suppressor grid of a pentode has an effect similar to that of applying negative bias to the control grid of a variable-mu valve. There are, however, two significant differences to be noted; first, the mutual conductance of a pentode can be reduced to zero by a sufficiently large suppressor bias but the mutual conductance of a variable-mu valve can only be reduced to a low value by application of control-grid bias. In other words the anode-current/suppressor-potential curve has a sharper cut-off than the anode-current/control-grid potential curve for a variable-mu valve. However, no distortion occurs even if the valve is biased near suppressor cut-off because the control grid is still modulating the full cathode current. Second, the cathode current of a variable-mu valve is reduced to a very low value by a large negative bias on the control grid, but the cathode current of a pentode is substantially unaffected by application of a large bias to the suppressor grid. This constancy of cathode current with variation of suppressor-grid bias plays an essential part in this a.g.c. circuit and is largely responsible for the simplicity of the circuit. The use of suppressor injection enables high-slope pentodes of the EF50 type to be used as automatic-gain-controlled r.f. or i.f. amplifiers.

A disadvantage of suppressor-grid control for valves of the EF50 type is that the suppressor-grid base is usually longer than the control-grid base of a variable-mu pentode, and a.g.c. voltages of the order of 50 volts are necessary for effective control. Thus d.c. amplification of the a.g.c. voltage is essential for effective control. This amplification can be achieved without the use of an additional valve, and successful circuits have been constructed in which the necessary d.c. amplification has been obtained (without effect on their normal function) from (1) an anode-bend detector, (2) the first a.f. stage following a diode detector, (3) a second r.f. stage, and (4) an i.f. stage.

A.g.c. amplifiers are, of course, commonly used in superheterodyne receivers more elaborate than the typical 4-valve type but most circuits require a negative h.t. supply to enable the quiescent anode potential of the d.c. amplifier to be slightly negative with respect to the controlled-valve cathodes. The provision of a negative h.t. supply is disadvantageous because it necessitates additional smoothing components, and possibly requires a further rectifier.

The necessity for such a supply can be avoided if the cathode potential of the controlled valve is made

*B.B.C. Engineering Training Department.

sufficiently positive with respect to earth potential for the control electrode to be directly strapped to the anode of a d.c. amplifier with its cathode approximately at earth potential. A high value of controlled-valve cathode resistance is required to give a high cathode potential and if the a.g.c. voltage is applied to the control grid the large negative d.c. feedback produced by the cathode resistor to a large extent nullifies the d.c. amplification. In other words when the control grid is driven negative the cathode current falls, resulting in a fall of cathode potential so that the resulting change in grid-cathode potential is relatively small. It is for this reason that negative h.t. supplies are almost universally employed in receivers where it is desired to amplify the a.g.c. If, however, the bias is injected into the suppressor grid, loss of a.g.c. voltage does not occur, because the cathode current is virtually independent of the suppressor bias.

Thus a skeleton form of a practical circuit is that shown in Fig. 2 in which the d.c. amplifier V2 is also an a.f. voltage amplifier, the a.g.c. voltage being injected into the control grid as shown. V1 is a controlled valve and its cathode potential together with the anode potential of V2 are both in the region of 100 volts. This high cathode potential has two advantages : it avoids the necessity for a negative h.t. supply as already explained ; it also reduces the screen-cathode potential of V1 to a value (150 volts approximately) at which the maximum safe screen dissipation is not exceeded even when all the cathode current is flowing to the screen, i.e., when the receiver is tuned to a strong signal. A separate screen dropper must not be used because the screen potential will then vary with suppressor bias and the cathode potential will also vary. If for any reason additional decoupling is required, the dropper should be made to carry the anode current in addition to the screen current to maintain correct performance.

If V2 is to have high d.c. gain its associated component values must be chosen with care. Typical values for anode load, screen dropper and cathode resistor for an a.f. voltage amplifier are 100kΩ, 330Ω and 2kΩ respectively. A stage with such components will probably have an a.f. gain of approximately 150 times, but the d.c. gain would be very much less and is unlikely to exceed 10 times. This low d.c. gain is due to negative d.c. feedback caused by the resistance in the cathode and screen circuits. When a negative potential is applied to the grid the cathode current falls, producing a drop in cathode potential and the screen current falls causing a rise in screen potential. These potential changes both tend to maintain the anode current constant, thus reducing the d.c. gain.

The ratio of the d.c. gain to the a.c. gain in such a circuit can be calculated from the expression applicable to any negative feedback circuit, namely,

$$\text{d.c. gain} = \frac{\text{a.c. gain}}{1 + gR}$$

The degeneration due to the cathode resistor R_k can be calculated by putting $R = R_k$ and $g = g_m + g_s$ where g_m is the mutual conductance and g_s is the screen conductance, i.e., the change in screen current for a 1-volt change in screen potential. If $g = 1$ mA/V and $R_k = 2\text{k}\Omega$, practical values for a high-slope pentode with a high-value of load resistor, the d.c. gain is one-third the a.c. gain.

In addition, however, there is degeneration due to the screen circuit and to calculate this g is put equal to g_s and R to R_{s_2}, the screen feed resistor. For a voltage amplifier typical values for g_s and R_{s_2} are 0.01 mA/V and 330 kΩ respectively. Substituting these in the above expression gives the d.c. gain as 1/4 of the a.c. gain. If degeneration is present in both cathode and screen circuits as in practice, the d.c. gain is likely to be only about 1/13 of the a.c. gain. This calculation, based on conservative values of g, emphasizes the need for low values of screen and cathode resistance in d.c. amplifiers.

The cathode potential may be stabilized by using a low-value cathode resistor through which is passed a constant bleed current which, to avoid unnecessary waste of h.t. current, can sometimes be the cathode current of other valves. The screen potential may be stabilized by feeding it from a low-resistance potential divider connected across the h.t. supply but this again implies waste of h.t. current. This loss may be avoided but the stabilizing effect retained by using a potential divider already present in the circuit, namely, the controlled valve V1 and its cathode resistor. The cathode current of the controlled valve may also be used to stabilize the cathode potential of V2. By this means a d.c. gain of the order of 100 times may be obtained from a voltage a.f. amplifier.

For correct polarity of a.g.c. voltage the grid of the d.c. amplifier must be driven positive by the d.c. component of the incoming signal; in other words if a diode detector is used its cathode must be connected to the control grid of the d.c. amplifier. For this reason a multiple valve such as a double-diode-pentode cannot be used for detection and d.c. amplification. A full version of this a.g.c. circuit is given in Fig. 3 in which the first a.f. amplifier also functions as d.c. amplifier.

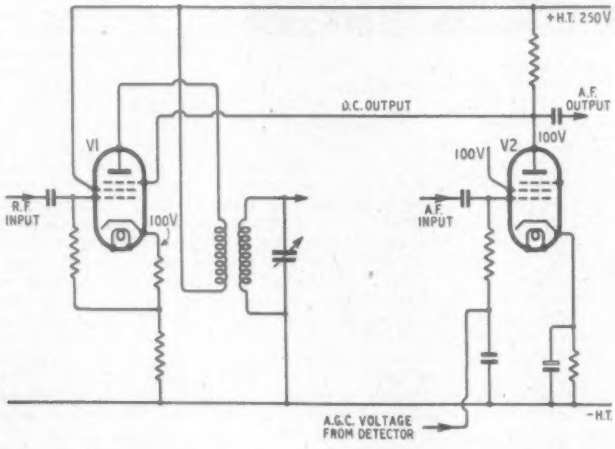


Fig. 2. Skeleton circuit showing electrode potentials in the d.c. amplifier section.

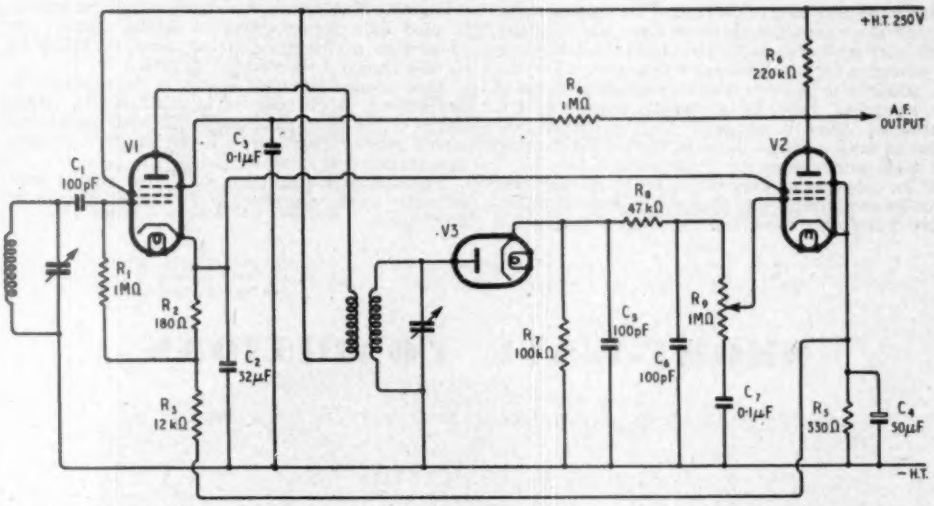


Fig. 3. One version of the amplified a.g.c. circuit in which an a.f. amplifier also functions as d.c. amplifier.

The screen of the audio amplifier must be decoupled by a large capacitor to minimize hum in the output and a 32-μF, 200-V component C_2 is used for this purpose. Moreover, to prevent a.f. signals being impressed on the suppressor grid of V1 an a.f. filter R_4C_3 is included in the suppressor feed. The detector circuit is unusual in that the d.c. blocking capacitor C_7 is included at the earthy end of the manual audio volume control R_9; by means of this circuit arrangement the full d.c. output of the diode is always applied to the grid of V2 irrespective of the setting of the volume control. R_5, the cathode resistor of V2, carries the cathode currents of V1 and V2 and is somewhat larger than might be expected; the larger value is necessary to offset the positive bias of approximately 1 volt which is given by the diode even in the absence of r.f. signals. The value of R_5 or R_6 is critical because between them they determine the quiescent anode potential of V2 and thus the suppressor potential of V1; one of these, preferably R_6, should be capable of adjustment and should be set so that the suppressor-cathode potential of V1 is zero with no signal input.

For successful results V1 must have a suitable, i.e., relatively short, suppressor grid base and the EF50 has been found satisfactory, the cut-off voltage being approximately -50 volts. The SP41 and SP61 are unsuitable because the suppressor base is longer and the anode potential of V2 cannot, without extensive rearrangement of quiescent circuit potentials, be made to change sufficiently to give adequate control. The anode potential of V2 will not normally go less than about $+20$ volts with respect to earth and a suppressor bias of -80 volts is insufficient to cut off an SP41. Valves with specially short suppressor grid bases such as the 6F32 would appear to be suitable for use in this type of a.g.c. circuit (possibly without d.c. amplification) but have not been tried because they are of lower slope than the EF50.

Valve manufacturers generally stipulate an upper safe limit to the cathode-heater d.c. potential and this is sometimes as low as 50 volts. It is therefore advantageous to keep this potential as low as possible and in the circuit of Fig. 3 the cathode-heater potential can be reduced by connecting the heater winding of the mains transformer to a tapping point on the cathode load of V1. If the winding is centre-tapped it is not usually necessary to decouple the junction point to earth, but if there is no centre tap decoupling may be necessary; a 4-μF capacitor is generally adequate. An advantage of biasing the heater supply is that it frequently brings about a welcome reduction of hum in the a.f. amplifier.

In an alternative form of the circuit V2 may be an r.f. amplifier, in which case R_6 may be a decoupling resistor. Alternatively V2 may be an anode-bend detector and this brings about a considerable circuit simplification; it is hoped in a subsequent article to describe a sensitive t.r.f. receiver using such a circuit. V2 cannot be a leaky-grid detector because the anode potential of such a valve goes positive when an r.f. signal is applied to the grid.

The chief disadvantage of this circuit is that the signal-handling capacity of V1 is limited, and not increased by a.g.c. bias as in conventional a.g.c. circuits. A straight r.f. pentode overloads for inputs exceeding approximately 1 volt peak, but this disadvantage may be overcome by careful design. For example if V1 is a first r.f. amplifier, overloading on strong local stations may be prevented by the use of wavetraps. If some gain can be sacrificed, overloading in general can be avoided by the use of current feedback in the cathode circuits of controlled valves. Current feedback may be applied in Fig. 3 by tapping C_3 and the screen of V2 down the cathode chain of V1.

The a.g.c. provided by this circuit has an inherent delay; this is due to the shape of the $I_a - V_{g3}$ characteristic (Fig. 1) which is substantially level for the first few volts of negative bias applied to the suppressor grid. Thus there is no reduction in controlled-valve gain until its suppressor bias has

fallen to the beginning of the knee of the characteristic. Because of the amplification of the a.g.c. bias this delay is not very great and can be eliminated if not required by arranging for the quiescent anode potential of the d.c. amplifier to be lower than the cathode potential of the controlled valve by a suitable amount. If a substantial delay is required it is probably best obtained from a biased diode in the normal manner, the diode output being d.c. amplified as before.

If the quiescent anode potential of the d.c. amplifier is made considerably less than that of the controlled-valve cathode, the maximum sensitivity of the receiver is limited. Such an adjustment is useful if the receiver is used only for reception of strong signal; the adjustment can be made in the circuit of Fig. 3 by suitable choice of the value of R_8 or R_9.

This circuit lends itself readily to the operation of an S-meter, which can be included in the screen circuit of the controlled valve. On weak signals the screen current is low and on strong signals it is high; thus the meter is forward-reading.

This circuit arrangement and other similar ones using the same principles are the subject of a patent application.

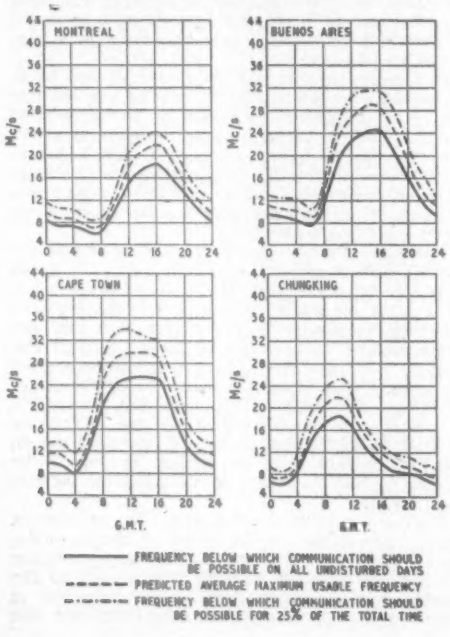
SHORT-WAVE CONDITIONS

August in Retrospect : Forecast for October

By T. W. BENNINGTON *

DURING August the average daytime maximum usable frequencies for these latitudes remained at about the same value as during July, instead of increasing as had been expected. The failure to increase was, no doubt, occasioned by the large amount of ionospheric storminess which occurred. The nightime m.u.f. decreased considerably, in accordance with expectations.

Daytime working frequencies were relatively low. Frequencies above 17 Mc/s were seldom well received over east/west paths, and over north/south paths 24 Mc/s was about the highest frequency for regular reception. Occasionally, of course, frequencies somewhat higher than these were workable over certain circuits. At night 11 Mc/s was usually workable till midnight or somewhat later, but frequencies as low as 7 Mc/s were necessary in the early morning hours.


MONTREAL
BUENOS AIRES
CAPE TOWN
CHUNGKING
Mc/s
G.M.T.
FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE ON ALL UNDISTURBED DAYS
PREDICTED AVERAGE MAXIMUM USABLE FREQUENCY
FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE FOR 25% OF THE TOTAL TIME

Sporadic E was less prevalent than during the previous month, though on a few days 28 Mc/s communication to European countries was noted as taking place by way of this medium.

Sunspot activity was, on the average, considerably lower than during the previous month.

August was a very disturbed month, and conditions remained subnormal for some very long periods. The ionospheric storms giving rise to these conditions occurred during the periods 1st-3rd, 13-15th, 17-18th and 20-28th. Only one Dellinger fadeout was reported and that was of minor intensity.

Forecast.—During October there should be a continued increase in the daytime m.u.f. for these latitudes, with a continued decrease in the nightime m.u.f.

Daytime working frequencies should, therefore, be relatively high, though on east/west circuits 17 Mc/s should remain about the highest regularly used frequency, with those up to about 23 Mc/s sometimes usable. Over north/south circuits frequencies up to about 26 Mc/s should be regularly usable during the daytime, and those up to about 33 Mc/s occasionally so. The medium-high frequencies will, however, have to be used for a larger proportion of the daily time, due to the decrease in the hours of daylight. At night 9 Mc/s will generally be of use till about midnight, but after that time 7 Mc/s, or perhaps 6 Mc/s, will be about the highest regularly usable frequency.

Sporadic E should decrease sharply in the frequency of its occurence, and little communication on high frequencies is likely by way of this medium. It is unlikely that the E or F_1 layers will control transmission at any distance and medium distance communication will therefore be by way of the F_2 layer, being possible on slightly higher frequencies by day and on lower ones by night, than during September.

The curves indicate the highest frequencies likely to be usable over four long-distance circuits from this country during the month.

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* Engineering Division, P.B.C.

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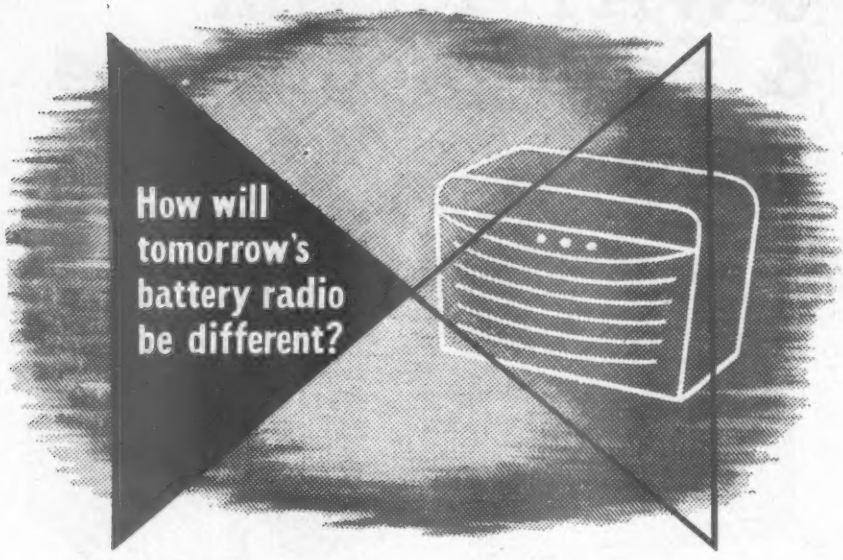

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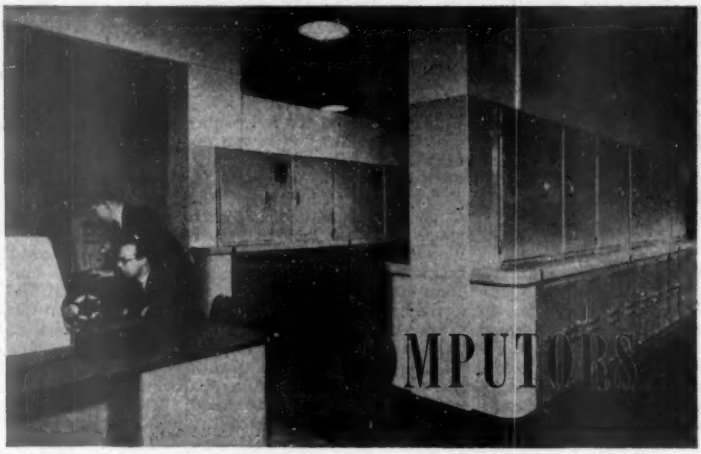


Where are the works? A computor looks like this when engineering design principles are applied to it. (The Manchester University machine built by Ferranti).

COMPUTORS

By

"CATHODE RAY"

Doing Sums Without Pencil and Paper

I HOPE the title will not lead anyone to expect a working knowledge of the subject in one easy lesson. It has already become so vast that a full-sized book could not give that. But since I had dealt last month with the binary scale, which is fundamental to most electronic computors, the Editor suggested that I might as well finish the job off by explaining computors themselves. Strictly between you and me, it sounded rather like the proverbial tramp who produced a button and asked the housewife if she would mind sewing a shirt on to it, but with ready tact I refrained from saying so. I did, however, try to make clear to him, as I now do to you, that the most I can attempt in one article is a rough idea of the principles on which automatic computors are based. I can hardly begin to go into details of circuits, still less give full instructions for making a nice little "electronic brain" at home.

Some readers may wonder why the subject comes into *Wireless World* at all. There are really two reasons. One is that wireless and its related technicalities soon lead to involved calculations, and anything which offers hope of helping with these is likely to be of interest. But anybody who would have the use of an electronic computor, and be capable of using it, would be far too learned to look to me for information.

The other reason is that these modern computors, which have caused such a stir, employ valves, neon tubes, cathode-ray tubes, relays—the familiar stock-in-trade of *Wireless World* readers. So it might seem a simple matter to explain computors on a basis of what you already know.

Unfortunately, with all due respect, this is not so. In the first place, it is a waste of time to study computor techniques before one has a clear idea of the operations of simple arithmetic—addition, subtraction, multiplication and division. I hope it is not a gross insult to *Wireless World* readers to suggest that there are any who lack this, but I do feel that most people—including even the mathematically inclined—perform these operations without thinking at all about the principles involved, just as most people who ride a bicycle would be hard put to it to explain clearly how they do it.

In the second place, the familiarity of the components and techniques is more apparent than real. But here I would probably have to make an exception of telephone technicians, because they are quite used to vast aggregations of circuits having numerous alternative connections and sequences of operation. Personally, I find that telephone engineers' diagrams rapidly induce a kind of mental paralysis. During the War the G.P.O. installed an electrical calculator at my radar station, and my mortification at seeing how confidently the G.P.O. man read the circuit diagram was only soothed when he confessed himself beaten by one little part of it—a very elementary radio adjunct!

Persons who are expert both in the theory of numbers and the practice of automatic telephone exchanges, therefore, probably take to electrical computors like ducks to water, but the rest of us are rather handicapped.

Coming now to the subject itself, I should make clear that calculating machines are far from new. Apart from the abacus, which was invented thousands of years ago, the principles of modern computors were worked out about 100 years ago by Babbage. Various mechanical calculators have been in use for many years, and one elaborate kind of electro-mechanical machine was familiar to the public long before the last war—the racetrack totalisator. The thing that is new is the enormous speeding up obtained by using electronic components instead of relays, etc. So in order of development—and speed—we have:—

(1) Mechanical.
(2) Electrical (or electro-mechanical).
(3) Electronic.

An electronic machine does not necessarily perform any additional *kinds* of calculation, but the mere fact of being a hundred or a thousand times faster makes it

practicable to do calculations that would otherwise take too long. Since 1945 a succession of electronic computors has appeared, beginning with the American ENIAC, which made a bigger impression on the public mind by the fact of its incorporating nearly 20,000 valves than for any of its mathematical achievements. The Ferranti machine, which was recently inaugurated at Manchester University, is more effective as a computor, but in the eyes of the journalist it suffers from the disadvantage of doing it with one tenth the number of valves.

The Two Kinds

All computors can be divided into two distinct kinds, *analogue* and *digital*. Analogue computors represent numbers or quantities by something else—length along a scale, angle of rotation, voltage, magnetic flux, etc. Probably the best known example is the slide rule. Distance along the rule is made to represent the logarithm of a number, and since adding the logs of two numbers gives the log of the product, multiplication can be done simply by adding together lengths of scale. Division is done by subtracting lengths; taking square roots by halving them, and so on. If the scales of a slide rule were uniformly divided instead of logarithmic, it could be used for simple addition and subtraction, but that would hardly be worth while except as part of a more complex machine. The predictor is a fairly complicated analogue computor, designed for the particular job of rapidly working out gunnery settings.

The best known digital computor (apart from one's fingers) is the abacus—that frame with beads strung on wires, supplied to infants with the hopeful intention of teaching them arithmetic under the guise of entertainment. That it is capable of more than this was shown in a contest between a Japanese virtuoso of the instrument and an American exponent of a modern digital computor—the commercial desk calculator—in which the Jap won every time.

The essential difference between the two classes is that digits or numbers are separate isolated things—the mathematical term is *discrete*—whereas the analogues are continuous. For example, one third cannot be expressed by any finite number (being 0.333333 . . . for ever), but one third of a distance is possible. In practice, however, this does not mean that the analogue principle leads to greater accuracy; quite the contrary, for a scale of manageable length has to be very carefully made if it is to be read reliably to even three significant figures, whereas digital systems can be made to handle figures with any desired number of "places" simply by duplicating components, like valves or relays, which in themselves call for no unusual precision of workmanship. The automatic telephone is a digital system, and the seven twists given (in the London area) to its mass-produced dial, generating seven groups of up to ten pulses, could be used to select any one of ten million different numbers. An analogue scale capable of being read unmistakably to one in ten million would be rather a formidable proposition for the instrument maker!

The limit of precision for reasonably economical manufacture is in the region of one in a thousand, and if one's needs come within that (as most everyday engineering calculations do) an analogue device is generally the cheaper way of meeting them. A digital computor capable of doing the work of a slide rule would be much more expensive. But the cost of obtaining greater precision by finer workmanship goes up very steeply indeed and soon soars beyond all possibility, whereas the curve for digital systems rises quite slowly, so in practice they are always adopted for really precise work.

Another way in which computors can be classified is according to the types of work they take off one's hands and brain. To follow this you will have to give a little thought to what you do when you perform a calculation without external aids; that is to say mentally, because pencil and paper are very definitely external aids. Suppose you have to work out how much a dozen articles at 19s. each are going to cost you. There are various ways of doing it, of course. The most obvious is to multiply 12 by 19 and if necessary divide by 20 to bring to pounds; but most of us never learnt the nineteen-times table, and find it rather a strain to do a long multiplication in our heads—the reason being that we may forget one partial result before the other is ready to add to it. But noting that 19 is one less than 20 we may multiply 12 by 20 and then subtract 12. We do the multiplication in two stages; first by 2 and then by 10. The first stage comes within the scope of the multiplication tables embedded in the memories of (we hope) most citizens. so after planning the whole sequence as above we draw on memory for the fact that $2 \times 12 = 24$. The advantage of the selected procedure is now apparent; there is no need to park "24" somewhere in our minds while we get on with another operation. Although 24×10 is beyond the twelve-times table, we draw on another file in our memory for the fact that multiplying by 10 in the decimal system of numbers merely requires a movement of one "place" or digit to the left, a "0" being added on the right to show this. Subtracting 12 from 240 is perhaps the stickiest bit, and it may be interesting for each of us to consider exactly how we do perform this part of the job. Do we first take away 10, reducing 240 to 230, and then another 10, reducing it to 220 and (making use of the memorized fact that $10 - 2 = 8$) add to the units column to give the answer 228s? Of course, if we wanted the answer in pounds and shillings we could have eased the work by bearing this in mind from the start, converting 12×20 shillings direct into £12 and then converting £1 of this into shillings in order to deduct 12s.

Dot and Carry One

I have gone into this simple piece of mental arithmetic at such length because it illustrates the three main departments of any computing system. There are one or (usually) more *operations*, such as addition, multiplication, etc. Then there is *storage* or "memory" of two kinds—permanent stores for such things as multiplication tables, and temporary stores or parking places for partial results. Then there is the planning and carrying out of the whole computation in *sequence*.

It is as a temporary store that a piece of paper is such a valuable aid. In long multiplication and division the results of the separate single-figure operations can be recorded on it until we are ready to add them together. Even in simple addition it is difficult to carry in one's head the figures that one is not actually dealing with at the moment.

Paper and pencil leave the brain to supply the permanent stores of information, but a slide rule takes over most of that job too. It also reduces the number of separate operations by dealing with two- or three-figure numbers at one go. So it needs less temporary

storage, and most of what is required is provided by its cursor. It is only when multiplications and divisions are interspersed with additions that there is need to record partial results on paper.* If a large number of similar calculations have to be done on a slide rule it is worth while spending some time and thought on sequence-planning, to accomplish each with the fewest movements of slides and cursor. For instance, if a formula such as $\frac{p \times q \times r \times s}{x \times y \times z}$ has to be worked out for numerous values of p, q, r, etc., it would be silly to do all the multiplications first and then all the divisions. It is best to divide p by x and multiply by q in one movement, and so on. And if a square or square root comes in, start on the right scale, so that there is no need to transfer from one scale to another.

The corresponding digital aid is the desk calculator. There are many varieties, but however they may be arranged mechanically the basic element is a counter. A motor car contains both analogue and digital instruments in one assembly—the speedometer uses pointer angle as the analogue of speed, and the mileage indicator, which is a counter, reckons distance in terms of figures. The usual decimal counter has for each digit a wheel bearing the ten figures 0—9 on its circumference. The wheel is arranged to be moved round one-tenth of a revolution for each unit of number. To count beyond 9 it is necessary to have a second wheel, for the tens digit, which the first wheel pushes forward one step whenever it turns from 9 to 0. Similarly for hundreds, thousands, and so on *ad lib*.

Although so simple, this device manages to do the "carrying" operation automatically at the same time as the addition. For instance, if the units wheel standing at 8 is pushed forward five steps it not only registers the correct units digit resulting from 8+5 but it also carries 1 to the tens position. To do the same thing with electrical components is not as easy as it may seem. The carrying may have to be done as a separate operation.

Neither the slide rule nor the desk calculator is automatic. The operator not only has to plan the whole sequence of operations; he has to carry them out. The next advance in computors was to make them automatic, or sequence controlled, so that the operator has only to do the initial planning or "programming," and the machine does the rest. The more refined types are capable of varying the sequence in the light of the partial results obtained, and in this lies their chief value. To take a simple example, the machine could be made to repeat a sequence of operations until the answer became negative, or equal to a stated number, or a maximum or minimum, and then start a different series of operations. Babbage thought all this out a century ago, but he was in advance of his time, and it is only quite recently that his ideas have been made effective.

So the modern automatic computor does everything except provide the problem and the programme. It is hardly fair to call it a "brain," however, because most of the real brain work goes into drawing up the orders so that the machine can carry them out. What the machine does is to take over the laborious and tedious routine operations, and (in the electronic types) at thousands of times the possible human speed and with far less likelihood of errors. Even a mathematician needs several weeks to learn how to instruct one of the big electronic machines. The trouble is that the instructions have to be made absolutely complete and unambiguous in every detail, and yet expressed in terms the machine can "understand"—usually punched holes in paper tape.

Even the instructions for multiplying one number by another are quite considerable. But a great deal of effort can be saved by building frequently used sequences (called sub-routines) into the machine. This is rather like what is done when a complicated plan (such as a military offensive) has to be put into effect at a moment's notice—the order can be reduced to "Operate Plan B" or a simple code word or number, so long as the details have been cut and dried in advance. A code number on the tape fed in brings into operation a previously prepared and stored record of the sequence to be followed by the machine.

Representing Numbers

And now I have just a little space left to mention some of the techniques employed in electrical and electronic computors.

First the analogue kind. One way of representing the numbers in the computation is by voltages. It is easy to add or subtract them by rotation of a potentiometer, forwards or backwards. Sines and cosines are obtainable by a suitably shaped potentiometer, or (with a.c.) by the angular position of a coil in an alternating field. The output of a potentiometer is proportional to its setting multiplied by the voltage applied to the input, so if both are under control it is possible to multiply. Another method of multiplication is to represent the variables by the currents in two coils; the force between them is proportional

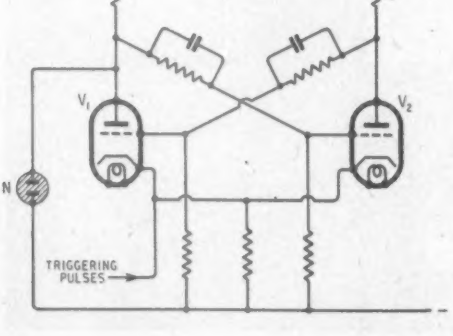
Control equipment for the pilot model of the N.P.L. automatic computing engine. Information on punched cards is fed into the Hollerith machine on the left.

* And not always even then; see "Basing Impedance Calculations," *Wireless World*, Jan., 1950.

to the product. An ordinary wattmeter goes one step farther and indicates the triple product VI cos θ, where θ is the phase angle between V and I. The current in one coil is, of course, I, and the current in the other is made proportional to V. The same scheme can be adopted in a computor by using one of the known methods of phase control to bring (say) an actual angle into the system. The household electricity meter goes still farther and integrates VI cos θ with respect to time; that is to say, multiplies VI cos θ at every moment by the infinitesimal duration of that moment, and adds the whole lot up to give kilowatt-hours. It does this by making the speed of a wheel represent the wattage; then the number of revolutions it makes is the time-integral.

Whenever a valve is used in an analogue computor it is practically compulsory to use lots of negative feedback, otherwise the readings are founded too much on the shifting sands of valve characteristics. This leads us to the point I was discussing last month when explaining the advantages of the binary arithmetical scale over the more familiar decimal one. Suppose the operative quantity in a valve circuit is its anode current, from zero up to a maximum of 10mA. Then a drift of 0.5mA would, in an analogue system, mean an error of 5 per cent of "full-scale deflection." In a digital system, drift would cause no error at all until it became large enough to slip a whole cog in the reckoning. If the decimal scale were used, there would have to be ten different distinguishable levels of anode current, and 0.5mA would be enough to bring it from spot-on to the limit of tolerance. The error caused by overstepping the limit would then depend on which digit was affected. If the correct answer were, say, 1,527, a slip from 0 to 1 in the millions digit would make this 1,001,527, which would contain rather a serious error! But with the binary scale it is only necessary to distinguish between off and on; current or no current. A neon tube can do that; or an ordinary relay. It would not be true to say that the decimal scale is altogether impracticable, because it is used quite successfully in the "Cin-Tel" counter, thanks to negative feedback; but it is doubtful how far the same policy could be applied in the more elaborate computors.

Fig. 1. Eccles-Jordan relay circuit, much used in electronic computors as a two-position switch.



Reducing the number of figures, or distinguishable states, from ten to two is such an enormous simplification that it is well worth having even though it means about three times as many digits, and also "translating" from and into decimal notation. For example, if numbers up to 9,999,999 are to be handled, it is easier to do it with twenty-four 2-way (on-off) switches than with seven 10-way switches.

Electronic Totting-up

The basis of a digital computor, as I said before, is a counter. The binary equivalent of the ordinary wheel counter would have only two figures on its circumference, 0 and 1. Each impulse to be counted would have to move it half a turn, so every second (instead of every tenth) impulse would carry one to the next wheel, pushing it round half a turn. And so on. The electronic version of this is the Eccles-Jordan relay (Fig. 1), published as long ago as 1918, and now often (not strictly correctly) called a flip-flop. This has two possible states: V_1 conducting and V_2 cut-off, or *vice versa*. Whichever state exists, a negative pulse applied to the cathodes reverses it; the action being rather like the overhead type of electric light switch in which one pull at the cord turns the light on and the next pull turns it off. If a neon tube N is connected as shown, the voltages can be arranged so that it lights up (indicating "1") when V_1 is cut off, and goes out (indicating "0") when V_1 conducts. By coupling the anode of V_1 to the cathodes of another pair, the change from 1 to 0 in the first pair can be made to cause a change from 0 to 1 in the second pair, making the indicated total rise from 01 (one) to 10 (two). The next pulse makes the first pair 1 again; total reading: 11 (three). To count beyond three, a third pair is needed. So it is easy to imagine why the ENIAC (which uses this system) needed 20,000 valves, bearing in mind the need for numerous storage arrays as well as those actually used for operations. There are more economical methods of storing numbers, but in the meantime let us see how some of the operations can be worked.

For simplicity, let us assume only five binary digits, capable of counting up to $16+8+4+2+1=31$. Suppose we want to add 9 to 13. The machine would be fitted with a switch for clearing all the registers (the rows of flip-flops) so that every digit is 0. Then "9" is fed into the machine. A special department converts this into the binary equivalent, 01001, and signals one of the registers in such a way that the first and fourth flip-flops from the right are triggered over into the "1" state. The 13 is then fed in, and the machine (acting all the time, of course, on the coded instructions issued by the programmer) translates it into 01101 and supplies it to the same register. By writing these numbers in the usual form for addition

01001
01101

we can see that the first flip-flop (extreme right) receives a second impulse, which will change it back to 0 and at the same time trigger the second to 1. The third is triggered to 1, and the fourth receives a second impulse which makes it 0 and carries 1 to the fifth. Result: 10110, which the binary-to-decimal translater interprets as $16+0+4+2+0=22$ and passes it to the output of the machine, either as light signals or (in the more expensive models) typed figures.

More often the numbers to be added are those that have been stored as results of other operations; and

the machine has to be able to respond to instructions such as "Take the contents of store X and add them to those in store Y."

Subtraction can be brought within the ability of an adding machine if the number to be subtracted is replaced by its *complement*. To take an example in decimal notation, subtract 127 from 26,454. The 5-figure complement of 127 is 99873, and adding this to 26,454 gives the right answer, 26,327 (ignoring the last 1 because it is outside the 5-figure limit). The binary system obviously makes this much easier, because all one has to do to get the complement is to reverse all the digits and add 1. Try it and see!

Multiplication is also very easy in the binary system, because it too reduces to the operation of adding, combined with shifting to the left. Suppose we want 9×13, or 1001×1101 in binary. If you write this out in long multiplication

$$\begin{array}{r} 1001 \\ 1101 \\ \hline 1001 \\ 0000 \\ 1001 \\ 1001 \\ \hline 1110101 \end{array}$$

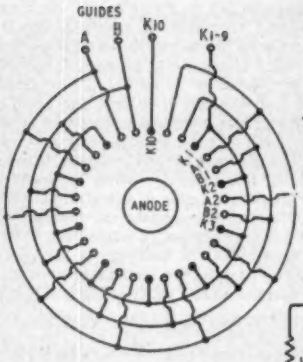
you will see that the first (units) digit in the multiplier (1101) requires the multiplicand (1001) to be taken as it stands. The second digit, being 0, requires nothing at all. The third requires the 1001 to be shifted two places and added, and the fourth requires it to be shifted three places and added. This is a comparatively easy extension of the adding circuits.

Division is a little more difficult, but if you try some binary long division, using the complement method to turn subtraction into adding, you will see that the only new thing the machine has to do is to time some steps of the programme for itself, depending on the result of the previous step.

Memory

Lastly, storage systems. If every binary digit to be stored either permanently or temporarily necessitates a pair of valves, the size and cost of the computor become alarming. That was the fault of ENIAC. Another fault is that if there is a power cut the machine is instantly afflicted with total loss of memory. So for permanent or long-period storage it is better to use magnetic recording, on tape or drum. The Ferranti Mark I computor contains a drum six inches by eight, which can store the impressive total of 650,000 binary digits. It also has eight cathode-ray tubes, each with a capacity of 1,280 digits, for more immediate use. All this is in addition to a moderate number of valve registers. The cathode-ray stores are a special feature of this machine, and obviously appeal strongly to me, but I have only room to hint that their working principle is very similar to that of the television camera tube. Since a charge pattern on a c.r. tube screen quickly fades, arrangements are made to "repaint" the whole lot about 30 times every second, but this does not prevent the machine from being able to pick out any line of digits on any tube in, at most, 0.00024 sec.

Other computors that have been built make much use of mercury storage. Pulses corresponding to the numbers to be stored are applied to one end of a tube filled with mercury, and they travel to the other as waves. When the waves reach the far end, which they



Left: Fig. 2. Arrangement of electrodes in the Dekatron tube. The ten cathodes are numbered K1 to K10. The two sets of guides, A and B, are for shifting the glow discharge from cathode to cathode.

Below: Fig. 3. How a Dekatron is shown in circuit diagrams.

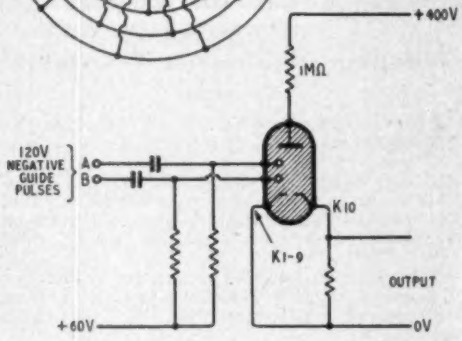
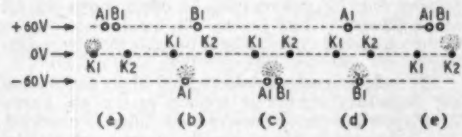


Fig. 4. Voltage diagram showing how the glow is passed from cathode to cathode by negative pulses on the guide electrodes.



do in about one thousandth of a second, they are received, amplified, and reintroduced at the input. In this way a record lasting one millisecond can be kept in existence indefinitely, and can be referred to any time it comes round.

One other device is, I think, worth mentioning, because it looks as if it would be very useful for less ambitious electronic computors than those we have been considering. It is a special kind of neon tube—the Dekatron—and is capable of recording numbers in decimal form. There is one central anode, with ten cathodes standing round it in a ring. The particular cathode that is taking the discharge is shown by the glow. The glow can be passed from one cathode to another, round the ring, by applying pulse signals to guiding electrodes, two of which stand between each pair of cathodes, and are connected together as in Fig. 2. All the cathodes, except the last, are also connected together, so the discharge can take place equally well to any of them. The guides are normally about 60V more positive (Fig. 3) so there is no tendency for them to act as cathodes, and the voltage is too low for them to act as anodes. Suppose the discharge has been established to cathode K1. If the A guides are all made momentarily more negative than the cathodes,

the discharge passes from K1 to A1 (Fig. 4). Just as the A guides are about to return to positive, the B guides are momentarily made negative, attracting the glow from A1 to B1. Finally the return of the B guides to positive shifts the glow to K2. The next pair of pulses on A and B shifts it to K3; and so on. The process is very like the party game in which the members of a team sitting side by side pass a ball along the line from one pair of feet to the next. When the glow reaches K10, this cathode (being separately connected) can be made to cause a signal that will carry 1 to the next tube, as in a mechanical counter.

I could use up a good many pages explaining how this and other electronic devices function in circuits, but I am expected to leave room for somebody to make at least a passing reference to the affair at Earls Court.

Eidophor Projection Television System

AMONG the papers read at the Television Engineering Session of the 1951 Radio Convention of the British Institution of Radio Engineers was one on the eidophor system. Sometimes known as the Fischer system after its inventor, who died in 1947, the eidophor system depends on the use of a film of oil as a modulator for a beam of light.

The equipment described in the paper by Professor E. Baumann, of Zurich, is the third prototype and was first operated in December 1950. The first model was tried out in 1944.

A film of oil is scanned by the electron beam of a cathode-ray tube which produces on the oil an electrostatic-charge pattern corresponding to the picture. The surface of the oil is deformed by this charge pattern and this deformation, in effect, turns the oil into a pattern of tiny prisms. In conjunction with a Schlieren optical system a light beam is thereby modulated.

The video signal modulates a 20-Mc/s carrier and the modulated carrier is applied to the c.r. beam. As a result a form of velocity modulation is obtained. The light source passes through a series of parallel bars to the oil film of the eidophor. It passes through the film, is reflected from the rear surface and passes through a second time back to the parallel bars of the Schlieren optical system. The adjustment is such that if the eidophor is unmodulated the light hits the bars and passes no farther. The prisms formed in the oil by the modulation, however, deflect the light in greater or lesser degree, with the result that the emergent light is intercepted to a varying extent by the bars and so a varying quantity of light passes between them. This is, of course, focused on the screen to form the picture.

The cathode-ray tube operates at 20 kV with a beam current of 80 μA. It is of the continuously evacuated type. The light source is an arc providing 45,000 candles per sq cm. The eidophor is of 75 sq cm and gives an effective light storage of about 70 per cent. It is slowly rotated so that a fresh surface is exposed for use and is maintained at constant temperature by a refrigerating plant. The final picture has an illumination of around 4,000 lumens.

The definition obtainable is independent of the light capacity and the equipment has been used up to 729 lines. The limits are stated to lie in the picture source rather than in the projector.

New Radar Display Unit

Details of the Type 12 Decca Marine Radar

THE 5-inch display unit (Type 159B) originally fitted in the Decca marine radar had the virtue of instant adaptability to all types of vessel from fishing craft to passenger liners, and was undoubtedly one of the reasons for the success of the original design (over 1,000 have already been installed).

To meet the requirements of the Navy, and also the demand from owners of the larger vessels, for bigger p.p.i. display, the Type 12 unit has been developed.

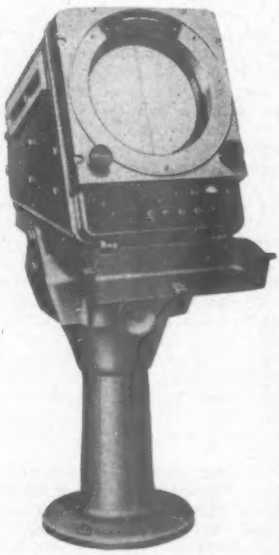
The 12-inch tube not only gives a high-definition display which can be read without the aid of a magnifier, but the larger mounting has enabled the designers to incorporate several new and interesting features in the circuit. Foremost among these is a new differentiating circuit which effectively analyses the returns from rain or snow areas and throws into relief targets which would otherwise lie hidden in a confused overlapping train of responses. This circuit, which can be switched out to give higher maximum sensitivity when not required, is effective up to maximum range and can be regarded as complementary to the sea clutter control at short ranges.

Dual-pulse-length transmission, automatically switched from 0.1 μsec for the 1- and 3-mile ranges to 0.2 μsec for 10 and 25 miles, is now employed to improve responses at long distances while retaining the high discrimination and minimum range of 25 yards on the short ranges. The range scales, which are logarithmic for constant percentage accuracy, are automatically selected by a shutter, coupled to the range control switch.

Mechanically, the Type 12 display unit is extremely robust. The housing is a machined aluminium-alloy casting with internal runners which enable the display chassis to be drawn forward for servicing, and is attached to the trunnion base by four resilient rubber mountings.

The rest of the equipment—scanner, receiver unit and power supply — is the same as in the Type 159.

A new factory has been equipped with special machinery to turn out this new set in sufficient quantities to supply the needs both of the Navy and the mercantile marine.



Pedestal mounting for Decca Type 12 display unit, which can also be supplied for shelf-mounting if required

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Efficiency Line-Scan Circuits

(*Concluded from page 350 of the September issue*)

Part 3—Transformer Coupling

By W. T. COCKING, M.I.E.E.

As soon as a transformer or auto-transformer is included in the time-base circuit its operation becomes much more complex. If h.t. boost is not used the only benefits to be gained by using a transformer are the absence of a d.c. component in the deflector coil, the ability to use a deflector coil of any required inductance and the ability to operate the diode with its cathode earthy. This last benefit is only obtainable with a double-wound transformer. To offset these advantages, the transformer reduces the efficiency of the circuit. It does this in three ways: energy is needed to establish the magnetizing field in the core; energy is needed to establish the inevitable leakage field; and energy is needed to provide for the eddy-current and hysteresis losses of the core. In addition, the equivalent circuit becomes that of a coupled pair of resonant circuits instead of that of a single circuit; it has two natural frequencies of oscillation instead of one and it is not possible to control both by means of a single diode.

The inductive effects of the transformer are on the scan exactly equivalent to a change in the effective value of the $L_L I_L^2$ figure of the deflector coil and the efficiency may be reduced by as much as 50 per cent. The core losses affect the total Q of the circuit and, hence, the amount of overshoot, which in turn affects the current efficiency of the output valve in the manner already described.

The total effect of a transformer on circuit efficiency can be very considerable. The basic efficiency of a circuit using a transformer is always less than that of one embodying a directly-fed deflector coil but, of course, the latter is not always practicable.

When h.t. boost is used, however, conditions are rather different. The energy recovered in the diode auto-bias circuit, and otherwise dissipated as heat in the bias resistor, is then utilized as part of the h.t. supply to the driving valve. This power fed back may exceed the loss introduced by the transformer and result in the total input power with the transformer-fed coil being less than with the directly-fed coil in spite of the transformer losses. This condition is most likely to pertain, and h.t. boost is certainly most valuable, when the h.t. supply is limited to a low value, as when it is derived directly from the mains without a mains transformer.

There are several different equivalent circuits of a transformer but the most suitable one for the present purposes is shown in Fig. 9. The real transformer of primary and secondary inductance L_p and L_s and mutual inductance M has a ratio of primary/secondary turns n. It is equivalent to (b) in which an ideal transformer of ratio $nk:1$ is connected to the network of inductances which simulate the field deficiencies of the real transformer. The leakage inductance is represented by $L_s(1-k^2)/k^2$ and the finite inductance of the transformer winding by L_p, where k is the coupling coefficient and equals $M/\sqrt{L_pL_s}$. The primary inductance is $L_i = n^2L_p$. This diagram does not take into account core losses.

Now if a deflector coil of inductance L_L and requiring a peak-to-peak current I_L is connected to terminals 3, 4 in Fig. 9 it is obvious that L_p must draw a similar current. A voltage L_LI_L/τ_1 exists across the deflector coil and also across L_p, but it cannot do this unless L_s is taking a current I, such that $L_sI_s/\tau_1 = L_LI_L/\tau_1$; therefore, $I_s = I_LL_L/L_s$. The total current flowing in the ideal transformer secondary and through the leakage inductance is thus

$$I_{sT} = I_s + I_L = I_L(1 + L_L/L_s) = I_L/\eta_i \quad .. \quad (7)$$

where η_i is the current efficiency factor of the transformer. The primary current is, of course, $I_p = I_{sT}/nk = I_L/nk\eta_i$

The back e.m.f. across the deflector coil is $E_L = L_L I_L/\tau_1$. The back e.m.f. across the secondary of the ideal transformer is greater than this by the back e.m.f. across the leakage inductance and this is $L_sI_{sT}(1 - k^2)/k^2\tau_1$. The total voltage on the ideal transformer secondary is thus

$$\frac{L_sI_L}{\tau_1} \cdot \left[1 + \frac{L_s}{L_L}(1-k^2)\right]\frac{1}{k^2} = \frac{L_LI_L}{\tau_1}\,\frac{1}{\eta_v} \quad (8)$$

where η_v is the voltage efficiency factor of the transformer. The total primary voltage is, therefore, $E_p = nkE_L/\eta_v$.

The product $I_pE_p = E_LI_L/\eta_v\eta_i$ is a measure of the input power, just as $E_LI_L = L_LI_L^2/\tau_1$ is a measure of the deflector coil power. From the point of view of efficiency, therefore, the circuit behaves during the scan as though the deflector coil had a figure of merit of $L_LI_L^2/\eta_v\eta_i$ instead of $L_LI_L^2$. It is quite easy to show from these relations that the efficiency is a maximum when

$$L_s = \frac{L_L}{\sqrt{1-k^2}} \quad .. \quad .. \quad .. \quad (9)$$

and that then

$$\eta_i = \eta_v = \frac{k}{1+\sqrt{1-k^2}} \quad .. \quad .. \quad .. \quad (10)$$

The coupling coefficient is thus very important. On

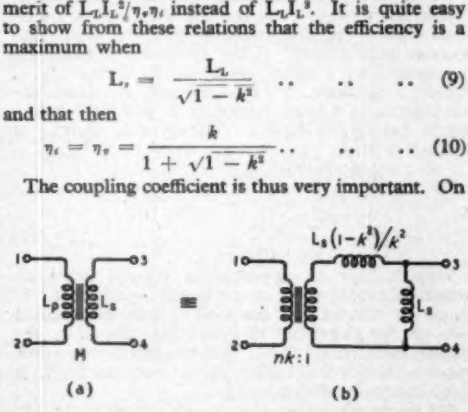

Fig. 9. Transformer (a) and its equivalent circuit (b).

account of the need for high insulation and low self-capacitance it is difficult to use many interleaved sections for the primary and secondary windings, which is the usual way of reducing leakage. In some cases it is not easy to make k greater than 0.98. With this value $k^2 = 0.96$ and $\sqrt{1-k^2} = 0.2$, so that the optimum value of $L_s = 5\,L_L$ and $\eta_i = \eta_c = 0.98/1.2 = 0.817$. The "power" efficiency of the transformer is thus only $0.817^2 = 0.66$.

Viewed from the transformer primary the total effective inductance is

$$L_{pT} = n^2k^2\left[L_s\frac{1-k^2}{k^2} + \frac{L_L L_s}{L_L + L_s}\right] \quad .. \quad (11)$$

and when L_s has its optimum value this reduces to $L_{pT} = n^2L_L$.

If a transformer-coupled deflector coil is used in the circuit of Fig. 1 (Part I), therefore, the effect is to a first approximation the same as if a coil of inductance n^2L_L were used and this coil had a figure of merit of $L_L I_L^2/\eta_i\eta_c$. An example may help to make this clear. In Part I we considered the case of $L_L I_L^2 = 2.9$ mH-A^2 and with the overshoot $x = 0.8$ we found $L_L = 22.3$ mH and $i_a = 46.6$ mA. Suppose we now wish to make $L_L = 5$ mH, $L_L I_L^2$ remaining unchanged, and the peak current of the valve is still 200 mA. If the coupling coefficient of the transformer is 0.98, $L_s = 5L_L = 25$ mH. The effective $L_L I_L^2$ figure is $2.9/0.66 = 4.4$ mH-A^2. If the overshoot is unchanged the mean anode current is unchanged and so the current output of the valve and circuit is still 360 mA. The effective inductance $n^2L_L = 4.4/0.35^2 = 34$ mH and so $n = \sqrt{34/5} = 2.6:1$. The primary back e.m.f. is $34 \times 10^{-3} \times 0.36/82.77 \times 10^{-6} = 148$ V.

As compared with the directly-fed coil, therefore, the use of a transformer results in the primary scan back e.m.f. being increased from 96 V to 148 V and the h.t. supply voltage must be increased by the difference, 52 V. The peak voltage on the fly-back also increases in the same proportion but the currents are unaffected. The necessary increase of power input has here been taken purely as a voltage increase because the peak current of the valve has been considered as the current-limiting factor. If this limitation did not apply the increase of power could be taken in the form of current rather than voltage.

To a first approximation the same equivalent circuit holds on fly-back and the effect of the transformer losses on the overshoot can be taken into account quite simply. If the deflector coil losses are represented by a shunt resistance R_L it has $Q_L = R_L/\omega L_L$; similarly, if the transformer losses are represented by a shunt resistance R_s to L_s, the transformer has $Q_s = R_s/\omega L_s$. The Q of L_s and L_L in parallel is thus,

$$Q_T = \frac{R_L R_s}{R_L + R_s}\Big/\frac{\omega L_L L_s}{L_L + L_s}$$

$$= Q_L\,\frac{1 + L_L/L_s}{1 + Q_L\,L_L/Q_s L_s} \quad .. \quad .. \quad .. \quad (12)$$

This is only an approximate relation since no account has been taken of the leakage inductance. It should be noticed that the total Q does not depend only on the individual Q values but also upon the relation between L_L and L_s and in consequence a low transformer Q will not affect matters very much if L_s is high enough in relation to L_L.

We found previously that for an overshoot of 0.8, $Q_L = 7.05$. A transformer with a ferrite or dust-iron core will have a higher Q than this, but one with a core of 0.014-in silicon-iron laminations may well have a Q of no more than unity! With this value, and when $L_s = 5L_L$, the total Q becomes,

$$Q_T = 7.05\,\frac{1.2}{1 + 7.05/5} = 3.5$$

and the overshoot $x = e^{-\pi/7} = 0.64$

This, of course, changes all the other conditions and the primary current drops to 328 mA, while the mean anode current rises to $84/1.64 = 51$ mA. The effective primary inductance becomes $4.4/0.328^2 = 41$ mH and so $n = \sqrt{41/5} = 2.86:1$. The primary back e.m.f. becomes $41 \times 0.328 \times 1000/82.77 = 163$ V. The input power needed, apart from the anode dissipation of the valve is $163 \times 0.051 = 8.3$ W instead of the 4.56 W needed by the directly-fed coil. It must again be emphasized that because of the idealized approach these figures, although comparative, are appreciably smaller than practice indicates.

Oscillations with Primary Diode

The circuit diagram of this transformer-coupled stage is shown in Fig. 10. In this the actual transformer shown is the ideal one with the elements of Fig. 9(b) added to represent the real transformer. Also the primary and secondary circuit capacitances C_p and C_s have been added. So far it has been considered that C_s is negligible, but in practice it is not. When the diode V_3 is conductive over the initial part of the scan it can control only the voltage on the left-hand side of the leakage inductance and the current through it; the resonant circuit to the right is not under its full control.

It is true that if the currents in L_L and L_s decay linearly the voltage across them will be constant and C_s will draw no current. Because the leakage inductance separates these components from the diode, however, the current is not forced to decay linearly and, in fact, it will not do so. The decay tends to be oscillatory. Ignoring any effect of the resistance losses on frequency, and regarding the diode as an effective short-circuit on the primary, the natural frequency of unwanted oscillation occurs at the frequency for which C_s resonates with the secondary and leakage and deflector-coil inductances all in parallel. When the optimum value of secondary inductance is used this frequency is given by:—

$$f = \frac{1}{2\pi\sqrt{L_L C_s}}\sqrt{\left[\frac{1+\sqrt{1-k^2}}{\sqrt{1-k^2}}\right]} \quad .. \quad .. \quad (13)$$

In the example considered earlier we had $L_L = 5$ mH, $k = 0.98$, if we assume $C_s = 200$ pF, — a probable value, since it includes the deflector-coil self-capacitance, we get $f = 390$ kc/s. The time of one cycle of oscillation is 2.6 μsec and so on a 10-in picture the effect would be to produce bright bars $2.6 \times 10/82.77 = 0.31$ inch apart with dark bars between them.

In practice such oscillations are liable to occur but are modified by the losses in the components. There is a damped sine wave of oscillation superimposed on the linear scan current and it is rare for more than about four bars to be visible on the picture.

It is not an easy matter to avoid this form of oscillation. What is required is a method of damping the subsidiary resonant circuit without damping the main one but this cannot be done by components connected to the circuit. However, the general circuit losses

increase with frequency and so are more effective in damping this subsidiary circuit than the main one, which is set at about 32 kc/s by fly-back considerations. The aim in design should be, therefore, to make the natural frequency of the subsidiary circuit as high as possible. The first step is obviously to keep C_s as small as possible, but no great improvement here is practicable—it would be at most about 2 : 1 in frequency.

The deflector coil inductance L_L can be reduced, in theory, without limit. In practice, however, there is a limit since if the inductance is too low the wire needed will become too thick for easy manufacture. Coils of less than 1 mH are rare. The improvement here seems limited to about 2 : 1 in frequency. The other factor affecting frequency is the coupling coefficient k and again quite a large increase is needed to increase the frequency very much.

Since h.t. boost cannot be obtained with a primary diode and since it seems so much better to dispense with the transformer entirely and use a directly-fed coil when h.t. boost is not used, it would not seem profitable to pursue the operation of the primary diode further. The invariable modern practice is to have the diode on the secondary side of the transformer and very often connected to the deflector coil. With a double-wound transformer this permits the diode cathode to be earthy and avoids difficulties in the heater supply; however, with an auto-transformer, which is now the common practice, the diode cathode is still "hot."

The circuit with a secondary diode is shown in Fig. 11. The transformer has again been shown by its equivalent circuit and the windings of the ideal

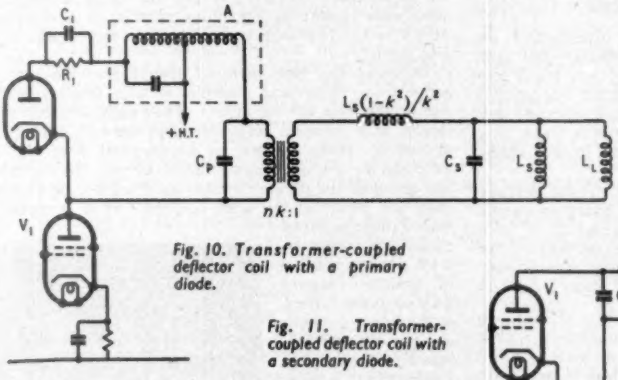

Fig. 10. Transformer-coupled deflector coil with a primary diode.

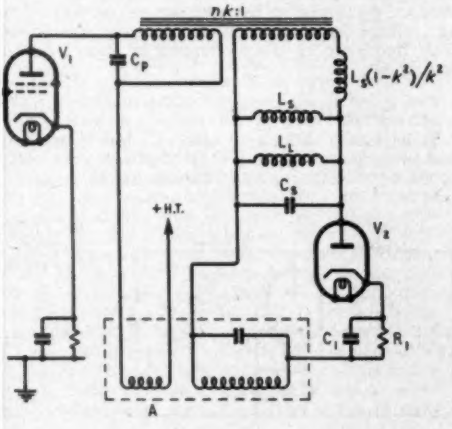

Fig. 11. Transformer-coupled deflector coil with a secondary diode.

transformer in it have been drawn end-to-end to bring out clearly the phase-reversing connections. The secondary circuit is shown as "floating"; in practice, some point is made earthy, but this point can be anywhere.

The equations of Part 1 need slight modification to cover this circuit, because the valves operate on the two sides of the transformer instead of both on the same side. The formula for the anode current i_a of V_1 is unchanged. As V_2 is now in the secondary circuit it carries part of the secondary current instead of part of the primary and this is nk times the primary current. The equation for the mean diode current thus becomes

$$i_d = \frac{i_p}{2} \cdot nk \cdot \frac{\tau_1}{\tau} \cdot \frac{x^2}{1+x} \quad .. \quad .. \quad .. \quad (14)$$

If h.t. boost is to be used it is necessary for the mean currents of V_1 and V_2 to be equal and this requires

$$n = 1/x^2k \quad .. \quad .. \quad .. \quad .. \quad .. \quad (15)$$

so that the transformer ratio is dependent on the overshoot obtained and hence on the Q of the circuit. This value of the ratio is really a minimum one; it can always be higher at the expense of boost voltage, for a resistance can be provided to absorb the surplus diode current.

With this additional information we can compute the requirements of a secondary diode circuit. We had before $k = 0.98$, $x = 0.64$, $i_p = 200$ mA, $L_L I_L^2 = 2.9$ mH-A^2, $L_s/L_L = 5$, $\eta_i = \eta_v = 0.817$. The total peak-to-peak current referred to the primary remains unchanged at 328 mA.

The transformer ratio is $n = 1/0.4 = 2.5$ and so the peak-to-peak secondary current is $0.328\ (2.5 \times 0.98) = 0.8$ A and the deflector coil current is $0.8\eta_i = 0.65$ A. The inductance must be $L_L = 2.9/0.65^2 = 6.8$ mH and $L_s = 34$ mH. Since the transformer conditions have been chosen to be optimum the effective inductance at the primary is $n^2L_L = 42.5$ mH and the primary scan back e.m.f. is $42.5 \times 0.328 \times 1000/82.77 = 169$ V. This is the same as with a primary diode, as it should be (the actual figure obtained was 164 V—the difference is negligible and is brought about by working to a slide-rule accuracy only). If h.t. boost is not used, the power input is therefore the same whether the diode is on the primary or the secondary.

Since the diode V_2 is across the secondary, the voltage appearing across R_1 is limited to the back e.m.f. across L_L; that is, to $6.8 \times 0.65 \times 1000/82.77 = 53.5$ V. This is the maximum boost voltage available. If it were possible to connect the diode to the other side of the leakage inductance the boost voltage would be 69V. It is not, however, and the energy stored in the leakage inductance is lost.

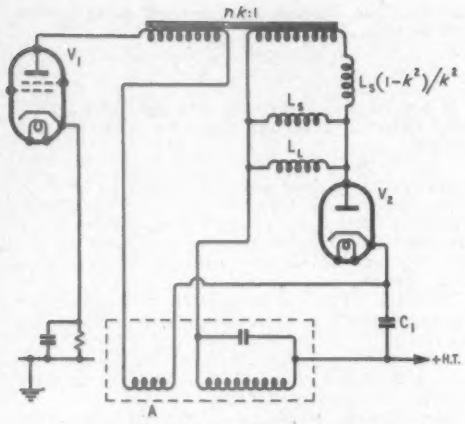

Fig. 12. Circuit of Fig. 11 re-arranged to give h.t. boost.

The circuit arranged for h.t. boost is shown in Fig. 12 ; the resistor R_1 has disappeared since the power previously dissipated in it is now taken by V_1. The voltage appearing across C_1, 53.5 V in the example, adds itself to the h.t. supply, so that this can be 53.5 V lower than without boost. In effect, therefore, it is as if the back e.m.f. on the transformer primary were this much lower than it really is, or 169−53.5 =115.5 V only. This makes the input power 115.5× 0.051=5.8 W.

Oscillations with Secondary Diode

Comparing the three conditions investigated we find the power is 4.56 W for the directly-fed coil, 8.4 W for a transformer feed without h.t. boost and 5.8 W with h.t. boost. Again it must be emphasized that these figures are based on an idealized approach and will be appreciably greater in practice ; also that they do not include anode dissipation in V_1, which will be at least 5 W.

It has been said that the energy in the leakage inductance cannot be recovered. It must, however, be dissipated and it is liable to expend itself in a damped oscillation in the resonant circuit formed by the leakage inductance and the primary capacitance. The frequency of this oscillation is given approximately by

$$f = \frac{1}{2\pi\sqrt{[n^2L_s C_p(1-k^2)]}} \quad .. \quad .. \quad .. \quad (15)$$

It is usually diffcult to make C_p less than 50 pF and so for our example $f=1/[6.28\sqrt{(6.25\times 34\times 10^{-3}\times 50\times 10^{-12}\times 0.04)}]=2.46\times 10^5$c/s=246 kc/s.

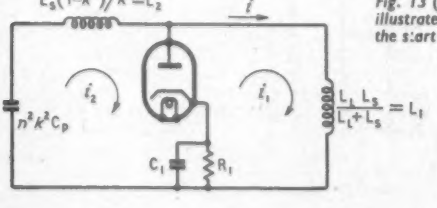

Fig. 13 (left). This circuit illustrates the conditions at the start of the scan.

The effect of this oscillation on the picture is much less serious than in the case of a primary diode for the deflector coil is not a part of the oscillatory circuit. In fact, the oscillation occurs in a separate circuit and is only coupled to the deflector coil by the internal resistance of the diode. If the diode is of low enough resistance, therefore, the effect on the picture may be negligible. The oscillation itself can be prevented only by the same means as with a primary diode, namely by making its frequency high enough for the circuit losses to be effective in damping it out.

One effect of the oscillation is profoundly to modify the waveform of the current through the diode. Consider Fig. 13, which shows the essentials of the circuit during the conductive period of the diode. At the start of the scan when the diode becomes conductive there is a peak (electron) current i flowing in the direction shown and it is in magnitude $x\ I_L/\eta_i$. The current is being driven around the circuit by the energy stored in the magnetic fields of the inductances. The back e.m.f. across L_1 is at this instant equal to the voltage across C_1, so that if the diode is regarded as a switch which closes at this instant, there is no current in it. The current in L_1 is forced to decay linearly by the diode but that in L_2 is not and decays more rapidly and in oscillatory fashion. The current in the diode, therefore, grows gradually, reaches a maximum and falls off again ; this process is repeated while the oscillations persist.

The action is more easily visualized by considering the current as made up of two independent currents i_1 and i_2. Initially, when the diode conducts they have the same amplitude and flow in opposite directions in the diode. Now i_1 is the current in L_1 and decays linearly ; it has the usual triangular waveform shown in Fig. 14(a), but i_2 is a damped oscillation. The total current is the sum of the two, Fig. 14(b).

Initially, the two currents always have the same amplitude. The scan current i_1 falls linearly with the proper rate for the scan. The oscillatory current decays as a damped oscillation and the amplitudes of successive peaks follow an exponential law. It is essential to the proper operation of the circuit that the decay of the oscillatory current shall not be slower than the decay of the scan current. If it is slower, one or more positive peaks of the oscillatory current will be of greater magnitude than the values of the linear current at the same instants. The required total current is then a reverse diode current which the

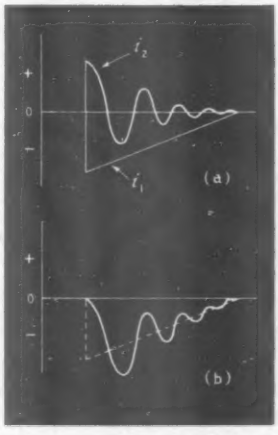

Fig. 14. The diode current is the sum of the scan current i_1 and the oscillating current i_2 shown at (a). The sum is indicated at (b).

diode cannot pass. The diode then cuts off and there is a severe disturbance of the scanning waveform.

The ratio of the amplitudes of successive peaks in the oscillatory current is $e^{\pi/Q}$ where Q is the effective value for the oscillatory circuit. The rate of decay between the first and second peaks is thus $I_1\ (1-e^{-\pi/Q})\ f$ where f is the frequency of oscillation and I_1 is the amplitude of the first peak. The slope of the linear current is $I_L/\tau_1\eta_1=I_1/x\tau_1$. The first must be greater than the second, therefore, we must have

$$x\tau_1 f(1-e^{-\pi/Q})>1$$

This is a sufficient requirement to avoid diode cut-off on the second cycle of oscillation but not on later cycles, for the exponential decay means that the slope is continually decreasing. In practice, this is not very important for the "linear" diode current also changes with decreasing slope because in normal operation the driving valve comes into action before the diode cuts off. This results in an increase in the magnitude of the diode current and a delay in its cut-off point. Usually, therefore, the above simple relation is adequate.

As an example, we found earlier for $x=0.64$, $\tau_1=82.77\ \mu$sec, $f=246$ kc/s. Therefore, we require $1-e^{-\pi/Q}>1/(0.64\times82.77\times0.246)=0.077$; therefore $e^{-\pi/Q}<0.923$, or $\pi/Q>0.08$ which gives $Q<39$ approximately. In actual fact the Q is not likely to reach this figure, but the writer has had trouble from an excessive Q. It is most likely to occur when the natural frequency is lower—perhaps 100 kc/s only.

The Auto-Transformer

From the point of view of efficiency in transformer design it is necessary to keep the leakage inductance and losses as small as possible. The auto-transformer has an inherent advantage over the double-wound transformer; the advantage is very small with a high turns ratio but very large with a small ratio. In fact, the leakage inductance becomes zero with a 1 : 1 ratio, for then the transformer degenerates into a shunt choke.

Consider a transformer (a), Fig. 15, with primary and secondary inductances L_p and L_s and mutual inductance M. As already mentioned this has the equivalent circuit (b) and the equivalence is established by equating the open and short-circuit impedances of the two networks. This leads to the relations:—

$L_2=L_s$

$L_1=L_s(1-k^2)/k^2$ where $k^2=M^2/L_pL_s$

$a^2=k^2L_p/L_s=n^2k^2$ where $n^2=L_p/L_s$

which make Fig. 15(b) identical with Fig. 9(b).

An equivalent for the auto-transformer, Fig. 15(c), can similarly be derived. The first step is to re-draw it as in (d). The equivalent circuit (b) still applies and the elements will be distinguished by a tick (′) when applying to the auto-transformer. Equating open- and short-circuit impedances gives:—

$$L'_2=L_s$$

$$L'_1=L_s\frac{n^2(1-k^2)}{(1+nk)^2}=L_s\frac{(n'-1)^2(1-k^2)}{(1+n'k-k)^2}$$

$$a^2=(1+nk)^2=(1+n'k-k)^2$$

where n' is the auto-transformer turns ratio; i.e., the ratio of $\frac{\text{turns between 1, 4}}{\text{turns between 3, 4}}$ in Fig. 15(c).

The ratio leakage inductance of $\frac{\text{auto-transformer}}{\text{transformer}}$ is given, therefore, by

$$\frac{(n'-1)^2k^2}{(1+n'k-k)^2}$$

Since $k\approx1$ and $n'>1$, $1-k\ll n'$ and the ratio is nearly $\left(\frac{n'-1}{n'}\right)^2$. If $n'=2.5$, we get $(1.5/2.5)^2=1/2.76$ which is not a very large improvement. However, if $n'=1.5$, we get $(0.5/2.5)^2=1/25$, which is very considerable.

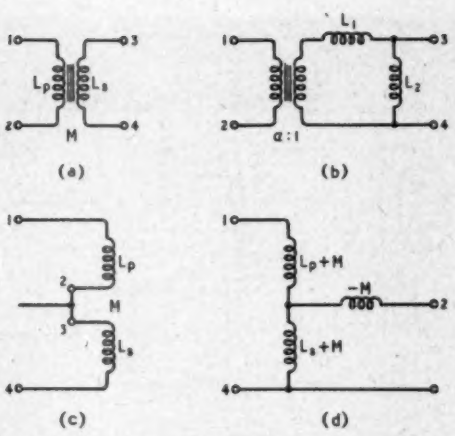

Fig. 15. Transformer (a), with its equivalent circuit (b). In auto-transformer connection (c) applies and has the equivalent (d) which can be reduced to the form of (e).

As long as the step-down ratio is small, say under 2 : 1, the auto-transformer is greatly superior to the double-wound transformer because a much smaller leakage inductance is obtained with the same form of construction. This not only improves the field efficiency of the transformer, since less energy need be provided to establish unwanted fields in it, but by raising the natural frequency of unwanted modes of operation it makes them much less likely to be troublesome. If h.t. boost is to be employed, and it is most valuable when the transformer ratio and leakage inductance are low, the use of a low ratio demands a large overshoot and, hence, a high Q circuit. If the ratio is to be under 2 : 1, the overshoot must exceed 0.7. It becomes almost essential to use a low-loss core material for the transformer and desirable also for the magnetic circuit of the deflector coil. Materials such as Caslam, dust-iron and Ferroxcube are needed.

The one practical inconvenience of the auto-transformer lies in the fact that the cathode of the diode is fluctuating at a high potential to earth and so must nearly always have its heater fed from a low-capacitance well-insulated winding of a supply transformer. Sometimes, too, the required inductance for the deflector coil becomes inconveniently high when the transformer ratio is low. This can be overcome by connecting it to a tapping on the secondary, so that there is in effect a double auto-transformer with one ratio between the driving valve and the diode and another between the driving valve and the deflector coil. Since there is then a further leakage inductance involved there are further possibilities of spur-

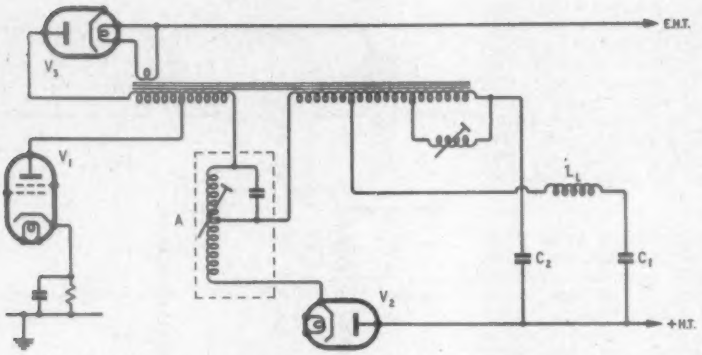

Fig. 16. Typical American scanning circuit using an auto-transformer and h.t. boost.

and many of the economy circuits are unsuitable for him unless he can obtain the proper components for them. The components are not easy to make by hand and also it is sometimes hard to obtain special materials in small quantities. The line-scan transformer is a particularly difficult component to make because it really requires a wave-winding machine.

Taking everything into account, the directly-fed deflector coil with a diode appears to be a very attractive form of circuit for the experimenter. H.t. boost is not possible with it, but this is of little moment in view of the absence of all transformer losses. It demands a special deflector coil, it is true, since the inductance must be unusually high, but a deflector coil is not difficult to make, only tedious.

ious oscillations. In all cases with a transformer or auto-transformer it is possible to make the primary a step up auto-transformer to feed an e.h.t. rectifier.

Circuits of this nature are used to scan 70° cathode-ray tubes operating at 14 kV and a typical one is shown in Fig. 16 in its essentials; V_1 is the driving valve and draws about 95 mA from an h.t. supply of 280 V. The damping diode is V_2 and the e.h.t. rectifier is V_3; it provides up to 16 kV on no load. An auto-transformer with a ferrite core is used and the winding is split for the insertion of the linearity control, which is the device A controlling the diode. Width control is obtained by a variable inductance shunted across a part of the transformer winding. The deflector coil L_L is tapped down from the diode connection and has a series capacitor C_1 to block any direct current. Although not shown in the previous circuits this is often necessary. Much depends on the precise arrangement of the components. The capacitor C_2 is the one across which the boost voltage is developed. Although not shown here, up to 12 mA at the boosted voltage can be drawn off for operating the frame time base.

Until recently British practice has favoured the double-wound transformer, but in general the output is only required to scan a 50°-tube at 9 kV. It is possible, therefore, to tolerate the higher leakage inductance of the double-wound transformer and it is not necessary to be so fussy about core losses. Laminated cores can, therefore, often be used, although the tendency is undoubtedly to abandon them. With the advent of 70° tubes, however, the tendency is undoubtedly towards the type of circuit shown in Fig. 16.

These economy circuits are quite complex in their operation and are affected by many factors. Thus, to quote only one example, a change in the quality of the transformer core material affects the Q of the circuit and so the overshoot. In its turn this affects the transformer ratio needed for proper matching of the currents when h.t. boost is used. There is, of course, some latitude permissible but, in general, they do demand more critical control over the circuit elements than the older heavily-damped circuits. This appears to cause no serious difficulty in production, but then it is possible to keep a close watch on the quality of materials.

The experimenter is in quite a different position

CLUB NEWS

Brighton.—The programme arranged for the coming months for the Brighton & District Radio Club (G3EVE) includes the Mullard television film-strips and a demonstration of recording and reproducing by the Decca Record Co. Meetings are held at 7.30 each Tuesday at the Eagle Inn, Gloucester Rd., Brighton, 1. Sec.: R. T. Parsons, 14, Carlyle Avenue, Brighton, 7, Sussex.

Edinburgh.—Meetings of the Lothians Radio Society have recommenced and are held on alternate Thursdays at 7.30 at the Edinburgh Chamber of Commerce, 25, Charlotte Square. Sec.: I. Harris, 24, Braid Hills Road, Edinburgh, 10.

Leicester.—At a recent meeting of the Leicester Ham Radio Society it was decided to drop the word "Ham" from the title and to cover every aspect of radio. The club meets at the Holly Bush Hotel, Belgrave Gate, on the first and third Mondays of each month. Sec.: L. Milnthorpe (G2FMO), 3, Winster Drive, Thurmaston, Nr. Leicester.

S. Manchester.—Until such time as new premises for the club headquarters can be secured meetings of the South Manchester Radio Club are being held in Tatton Arms, Northenden, on alternate Fridays. The next meeting is October 12th. Sec.: E. R. Taylor, 12, Marton Avenue, Didsbury, Manchester, 20, Lancs.

Southend.—The winter session of the Southend & District Radio Society (G5QK) opened with two Mullard film strips on cathode-ray tubes, the second of which, covering construction and manufacturing processes, is scheduled for September 28th. A lecture and demonstration on projection television will be given by a representative of Mullards on October 12th. At the following meeting (October 26th) Mr. Walters (Belling-Lee) will demonstrate a para-diagram plotter. Meetings are held at 7.45 at the Municipal College. Sec.: J. H. Barrance, M.B.E., (G3BUJ), 49, Swanage Road, Southend-on-Sea, Essex.

Five clubs in the counties of Lancashire, Cheshire and Denbighshire have co-operated in the formation of the Association of North Western Radio Societies, the main object of which is to co-ordinate corporate activities. The societies participating are, Chester & District A.R.S., Liverpool & District S.W.C., Wirral A.R.S., Merseyside R.S., and Wrexham & District A.R.S. Other north-western clubs interested are invited to write to W. G. Lloyd, 124, Tarvin Road, Chester.

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Telecommunications Research

Fundamental Investigations Undertaken by the D.S.I.R.

As in many other subjects, research in telecommunications may be broadly divided into two fields: (i) fundamental research designed to improve and extend our knowledge of the various basic phenomena upon which the practice of telecommunications rests; and (ii) research designed to use this knowledge for the development, operation and maintenance of telecommunication systems. In this country the first objective is met by the work of the Department of Scientific and Industrial Research, while the second category includes the activities of the research establishments of all Government departments, and associated organizations such as the B.B.C. and Cable & Wireless, and the industrial research laboratories.

It is not intended, however, to suggest that all work of a fundamental nature is conducted by the D.S.I.R. Many investigations of a very basic character have, of course, to be conducted in, for example, the research stations of the Post Office or the B.B.C., but such investigations are designed to fulfil the needs of the present or future services operated by these organizations. In a similar way, a large amount of basic research is carried out in industry, particularly in the sphere of the various kinds of materials and components, used for the manufacture and construction of telecommunications equipment. We will, however, confine ourselves to a description of the work of the D.S.I.R. which is conducted in close co-operation with all the various other interested organizations.

Mention should also be made of the fundamental research in progress at various Universities. Some of this is concerned with the study of radio wave propagation and radio-astronomy, while other parts of it involve a detailed study of the properties of materials of special interest to the telecommunications engineer and of the fundamental theory of the transmission of intelligence. Most of this work at the universities is supported financially by the D.S.I.R.

Automatic Recorder used by the D.S.I.R. for investigating the ionosphere and demonstrated at Earls Court is made by the Union Radio Co. of Croydon.

As is well known, the D.S.I.R. was established during the first World War to promote and organize scientific research, with a view especially to its application to trade and industry. In the field of telecommunications the term "industry" is deemed to cover operating organizations as well as those manufacturing apparatus and equipment. With the exception of medicine and agriculture, the Department embraces in its scope all branches of natural science and their application to industrial processes. Its activities fall under three main headings:— (a) research in the national interest for the benefit of the community as a whole and to meet the requirements of Government Departments; (b) the encouragement of research and the application of scientific knowledge in industry; and (c) the encouragement of fundamental research at universities and elsewhere, and the maintenance of an adequate supply of trained research workers for laboratories of all kinds.

To provide for the discharge of these functions in the radio field, the Radio Research Board was established in 1920 to advise the D.S.I.R. on the nature and scope of a programme of research work of a fundamental nature in directions where it was lacking and where it would be likely to lead to useful applications.

The constitution of the Board provides for representation at the highest technical level of those Government departments with an intimate interest in radio applications and of the B.B.C. with, in addition, several independent members, who may be from universities or industrial organizations. The present membership numbers 19, with Sir Stanley Angwin as chairman. To assist the Board in its work a number of technical committees are formed from time to time.

There are seven such committees constituted at present, each dealing with a different field of research: Ionospheric Wave Propagation; Tropospheric Wave Propagation; Direction Finding; Radio Navigational Aids; Radio Noise; Sub-standard Radio Measurements; and Radio Materials.

Much of the programme of work in the past has been conducted at the National Physical Laboratory, where a separate Radio Division was formed in 1933 with Sir Robert Watson-Watt as its first Superintendent. Following a consideration of its post-war programme, the D.S.I.R. in 1948 appointed Dr. R. L. Smith-Rose to the new post of Director of Radio Research to take charge of all the radio research work of the Department, a large proportion of which is now conducted at the Radio Research Station, Slough.

In 1948 a Standing Conference on Telecommunications Research was established under the chairmanship of Sir Stanley Angwin. It is hoped that the work of this conference will enable fundamental research to be directed towards meeting the most urgent needs of those engaged in any way in the development and practice of telecommunications. The Radio Industry Council, Telecommunications Engineering and Manufacturing Association, Cable and Wireless, B.B.C., I.E.E., Post Office and the Service and Supply Departments are represented at its meetings.

So much for the organizational side. Now a few

details of the investigations being conducted at the present time. For the purpose of investigating the ionosphere the D.S.I.R. maintains and operates two recording stations in the U.K., another in the Falkland Islands and a third in Singapore. It also has plans for assisting in the setting up of other stations at Ibadan, Nigeria, and at Khartoum, Sudan.

At the Earls Court National Radio Show a recorder was demonstrated which continuously probes the ionosphere with pulses at frequencies ranging from 0.6 to 25Mc/s. Height of reflection is automatically recorded. This apparatus allows investigations of the main characteristics of the ionosphere to be made and records their variations with season, time and place. Measurements are made at some 60 observation points all over the world on similar recording equipment, and through international co-operation results are collected by various national laboratories. This data is collated at the Research Station at Slough and made available to the communications industry each month, giving forecasts for a monthly period six months ahead of publication.

A comparatively new item on the research programme at Slough is the investigation of the behaviour of frequencies from 30 to 300Mc/s in relation to the troposphere (lower atmosphere). This is being conducted in co-operation with the B.B.C., G.P.O. and Meteorological Office. This study of the changing conditions of the troposphere will provide new knowledge on the behaviour of television signals, especially in fringe areas. For example, fog may produce an artificial reflecting surface which will give satisfactory reception well beyond the service area.

Still Higher Frequencies

Two types of research have been undertaken at frequencies above 3,000Mc/s. In one of these the electrical properties of constituents of the atmosphere, such as water vapour, water and ice, have been measured at the frequencies in question; while in the other, the results of actual propagation measurements over both land and sea are being studied in relation to the meteorological conditions observed simultaneously over the same paths. In the course of the latter investigation a study has been made in co-operation with the New Zealand D.S.I.R. of centimetre wave propagation over the Canterbury Plains in South Island, where somewhat special meteorological conditions exist.

In the field of direction-finding an investigation is being conducted with the aid of a continuous study of ionospheric conditions. Certain aspects of polarization error in direction finding at high and very-high frequencies are still being studied; and the present state of knowledge of the effect of siting conditions and local topography on the accuracy of direction finding at all frequencies is being reviewed.

In addition to investigations into the conditions which influence propagation, the Radio Research Station has given a great deal of consideration to the problems of signal/noise ratio. A theoretical study of the various types of noise has been made—that is, atmospheric, cosmic, man-made, receiver and thermal —and measurements obtained of their intensity and characteristics. Of the meteorological noises which affect reception, that from the atmosphere is produced by radiation from lightning discharges, and thunderstorms within 3,750 miles are potential sources of interference.

While the National Physical Laboratory is generally responsible for the development and maintenance of electrical reference standards which form the basis of all precision measurements at radio frequencies, there is a continuing need for the study of measuring technique, particularly at the upper end of the radio frequency spectrum. The development of new or more accurate measuring techniques and instruments is a necessary part of some of the investigations already referred to. For example, the study of propagation at increasingly higher frequencies has involved the development of field-strength measuring apparatus at frequencies up to, and above, 600Mc/s, and this in turn leads to the need for measuring power and voltage at such frequencies. In a similar way the use of transmission lines and aerial systems, as well as the development of new circuit techniques, assumes that facilities exist for measuring impedance at the working frequency.

Studies such as these lead eventually to the development of instruments of a sub-standard type, which Government and industrial laboratories need as their local reference. The Measurements Committee of the Radio Research Board has concerned itself mainly with making an appraisal of the present position of measuring techniques and instruments, with a view particularly to seeing to what extent existing designs evolved by research workers have been carried to a stage at which they may be developed by industry for general use.

One of the most pressing problems in the radio industry is the need for a basic study of the properties of the various materials—conductors, insulators and component parts of valves and their circuit attachments. The properties of certain materials of current interest are being examined at millimetre wavelengths, and much research work is in progress in university and industrial laboratories on the relation between the electrical properties and the chemical and physical structure of various dielectric and magnetic materials.

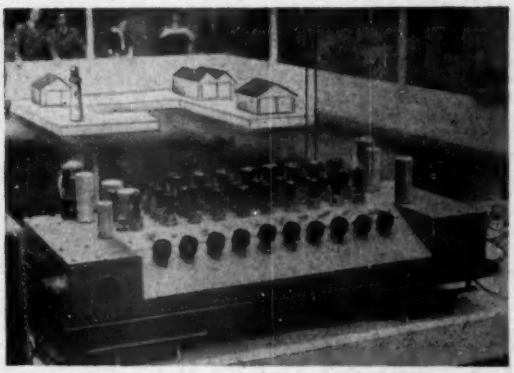
So much research work has been carried out in the past few years in this field that the Department has considered it desirable to prepare for publication a statement of present knowledge and the outstanding problems most urgently requiring research.

"Abstracts and References"

One of the consequences of the rapid spread of scientific research throughout the world is that the literature which, in effect, contains the increased knowledge resulting from this research effort has become greatly magnified. In the radio field, as in other branches of science, this literature, published either in periodicals or as the proceedings of scientific and technical institutions, has become so vast that it is increasingly difficult for the scientist and engineer to keep abreast of the progress being made in his own subject. In this connection an important factor is an efficient abstracting service; and so mention may be made here of the work undertaken by the Radio Research Board in the preparation of abstracts of the world's scientific and technical literature relating to all aspects of radio and its applications. These abstracts, totalling some 3,000 a year, have for many years been published monthly in our sister journal, *Wireless Engineer* and, more recently, also in the *Proceedings of the Institute of Radio Engineers* in the U.S.A.

Telearchics on Show

Developments in Control Systems



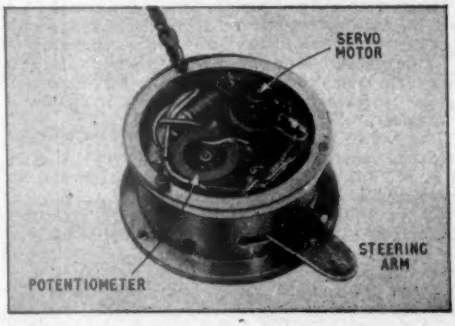
Control desk for one of the Philips radio-controlled boats at the Radio Show. In the background is the demonstration tank.

SOME of the principles outlined in our article on radio control last month were to be seen in practical form at two London exhibitions recently, the Radio Show and "The Model Engineer" Exhibition. At the first, Philips were demonstrating a couple of radio-controlled boats in a large tank specially built for the occasion. The smaller of these was quite a simple affair with only two control functions but the larger boat impressed everyone with the astonishing complexity of orders it was capable of carrying out. Not only could the engines and rudder be controlled, but lifeboats could be raised and lowered, a crane rotated, a seaplane catapulted off and various other devices put into operation.

All this is done on the one 100-Mc/s radio link by a multichannel system using pulse modulation. Each "order" is arranged to modulate a separate train of pulses of 9kc/s repetition frequency and the trains are interlaced and transmitted together with a sync pulse. Upon being received in the boat they are separated in the usual way by gate-pulse generators controlled by the sync pulse. For telearchics, the main advantage of this system is that it avoids weighty filter or tuning circuits at the receiving end. Furthermore, no interference can take place between the various control channels.

The rudder and other positioning controls were worked on the variable mark/space-ratio method described last month. At the transmitting end, each positioning channel has a square-wave generator with a variable control for altering the mark/space ratio and the output of this is modulated on to one of the 9-kc/s pulse trains. The modulation is 100 per cent, so the 9-kc/s pulses are either all there during a mark or completely absent during a space.

Servo unit made by the Low Speed Aerodynamics Research Association for operating control surfaces.



The same mark/space-ratio method was used in an aircraft shown at "The Model Engineer" Exhibition by the Low Speed Aerodynamics Research Association—but in rather a different way. In the receiver, instead of the square wave being used to switch a motor backwards and forwards all the time, it is smoothed out by means of a storage capacitor into a steady d.c. potential, which varies in proportion to the mark/space ratio. This potential, varying above and below a certain value, provides order signals for a servo-mechanism, which drives the control surface in one direction or other about its neutral position.

At the transmitting end the controlling square waves are generated in the form of bursts of oscillation from a transitron circuit, the variation of mark/space ratio being achieved by triggering the oscillator (which is normally biased off) at various levels on a 40-c/s sawtooth waveform—a bias control does this. The output from each oscillator then forms a subcarrier for the associated control channel and is modulated on to the main carrier.

Besides being rather more elegant for control purposes, this system improves on the basic method of pulse-width variation in that it does not waste power by switching the driving motor backwards and forwards all the time. Power is applied only when a change is introduced in the signal. The aircraft on show was provided with four channels: three positioning controls for rudder, elevators and ailerons and a channel for stopping and starting the engine.

Incidentally, the servo-mechanism mentioned above was a closed-sequence system, containing an amplifier, a motor and a potentiometer, arranged to balance against the variations of input controlling voltage. A positive or negative order signal causes the amplifier to energize the motor; this drives the potentiometer which feeds back a voltage error-signal to the input to neutralize the original increment or decrement, whereupon the system is restored to balance. The L.S.A.R.A. find this type of mechanism useful for a number of purposes so they have produced a more or less standard servo unit, containing a midget motor, potentiometer and actuating arm (see illustration), which can be fitted almost anywhere. At the Exhibition, they were demonstrating one of these in conjunc-

tion with a magnetic-compass potentiometer (a liquid device) to show how an aircraft can be kept on a set course—in fact, an automatic pilot. A deviation from course swings the compass needle (which forms the wiper of the potentiometer) away from its neutral position, and in this way a proportional voltage signal is produced to actuate the servo-mechanism and correct the deviation. Owing to the continuous and proportional nature of this arrangement, it is not so prone to hunting as the basic system described last month (see page 344) in which the steering motor is switched directly from two segments.

Re-activating Dry Batteries

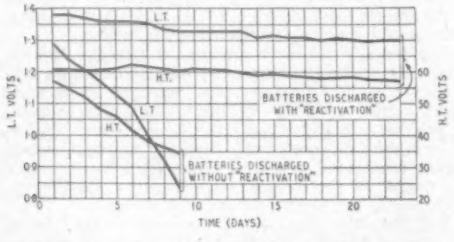
The Amplion "Activette"

By R. W. HALLOWS, M.A. Cantab., M.I.E.E.

THE dry battery represents "portable power" in its most convenient—but, unfortunately, in a distinctly expensive—form. Hence any device which can prolong the useful life of such batteries is sure of a welcome.

One reason why the dry battery is an expensive kind of power supply is that no way has ever yet been found of designing one in which the process of transforming chemical energy into electrical energy is able usefully to run its full course. Most batteries are discarded long before the zinc of the negative electrode has been used up, or the chemicals of the electrolyte and the depolarizer have become altogether inactive.

The main source of the trouble is that the depolarizer can never fulfil entirely the job assigned to it. Rising internal resistance *may* be due to loss of liquid from the electrolyte through evaporation; but that is a comparatively rare cause nowadays. In the vast majority of cases the rise is brought about by the failure of the depolarizer to deal sufficiently rapidly or sufficiently thoroughly with accumulations of hydrogen in the neighbourhood of the positive electrode.



Discharge curves, taken from an N.P.L. interim report, giving the results of the first 23 days' test of the "Activette." The terminal voltages shown are the average of those measured on load at the end of each day's two-period discharge.

It is not, then, surprising to find that the action of the Amplion "Activette," which is stated to be capable of endowing a given dry battery with five or six times its normal service life, is to speed up and intensify the process of depolarization within the cells. There seems, in fact, to be no other way in which service life could be prolonged, for the reaction of the electrolyte and the zinc is a non-reversible one: you cannot put zinc back on to the walls of the can or restore the condition of the electrolyte.

How the apparatus does its work has not yet been disclosed, on account of the position regarding patents. There can, however, be little harm in hazarding a possible explanation, and I will give you my guess in a moment.

The apparatus is contained in a metal box $4\frac{1}{2} \times 3\frac{1}{2} \times 1\frac{3}{4}$in in size. From the box comes one length of twin flex with a connection intended for 230-V 50-c/s a.c. mains, and two other lengths, one of which is to be connected to the terminals of a 69V—100V h.t.b., and the second to those of the single cell used for the l.t. supply of "all-dry" portables.

When the "Activette" is brought into action the mains power consumption is of the order of 3 watts. The working instructions are that after a battery has been in use for 2, 3 or 4 hours, the apparatus should be switched on for about the same length of time. It is of no use to apply it to a "dead" battery or cell, for it cannot re-animate.

This was done in the National Physical Laboratory tests, which, at the moment of writing have been in progress for 52 days. Reactivation took place for two hours before the first 2-hour run of the day, and for two hours again before the second daily run of the same duration.

The N.P.L. tests are comparative and, as the accompanying discharge curves show, they give one something to think about. Six batteries, bought from the same manufacturer, were used, all being of the 69-V h.t., 1.5-V l.t. type. The h.t. portion was discharged through a 10,000-Ω resistance, giving a drain of 6.9mA, and the l.t. portion through a 6-Ω resistance, taking 250mA.

Three of the batteries were "reactivated"; the other three were run in the normal way with no reactivation. At the end of the first run on the 52nd day the average voltage of the reactivated h.t. batteries was better than 57 and of the l.t. better than 1.2. All the untreated batteries were down to cut-off at the end of the 9th day's test.

How is it done? The metal case is stated to contain a transformer and my guess is that it contains also h.t. and l.t. half-wave metal rectifiers. It is conceivable that the application to a cell of a current consisting of a forward peak in one half-cycle, followed in the next by a slight reverse flow, may have a depolarizing action by its "shock effect" on the unwanted molecules of hydrogen.

The N.P.L. tests have shown that the "Activette" produces remarkable results on, at any rate, one make of h.t.b. There seems no reason why it should not prove equally effective on others.

I have referred only to the apparatus designed for dealing with the batteries of portable receivers. Another type has been evolved for the batteries of hearing aids. It is, I understand, likely to be at least a couple of months before either type becomes generally available.

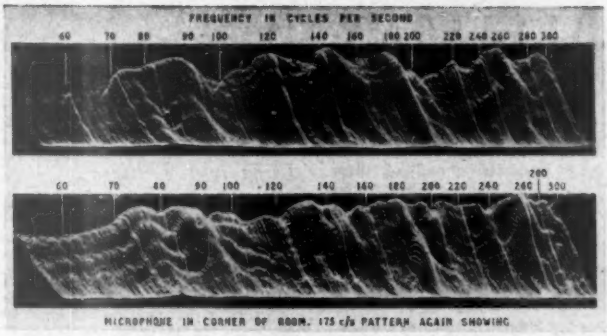


Fig. 1. Pulsed gliding tone reverberation records of a studio taken from two microphone positions.

Studio Acoustics

New Technique of Measurement Used by the B.B.C.

THE assessment of studio quality and the diagnosis of faulty acoustics are problems of great complexity, and whether judged by ear or investigated by measurement, often require long and intensive study before conclusions, capable of translation into practical remedies, can be reached.

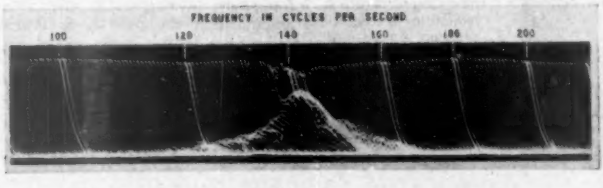
With pressure on studio space, for rehearsal as well as performance, the engineering staff of the B.B.C. is forced to make the best use it can of odd gaps in the programme schedule, and to this end has developed a new system of comprehensive measurement which can be recorded in a few minutes and subsequently studied at leisure in detail.

The source of sound is a pulsed gliding tone and a decay curve of the reverberation is displayed on a cathode-ray tube, the time base of which is triggered by the end of each pulse. A continuous record is made by a camera with slow film drive on 35mm film, and the succession of reverberation curves so produced presents the appearance of a relief model of a mountain range. The contour of the ridge, which represents the steady state level of sound built up by each pulse is of secondary importance to the pattern of the slopes. These reveal anomalies in the decay curve which may or may not be apparent in subjective listening tests. The curves of Fig. 1, which are for two different positions in the same studio, both show a sustained hangover in the region of 175 c/s the source of which would be subsequently located by detailed exploration at that frequency.

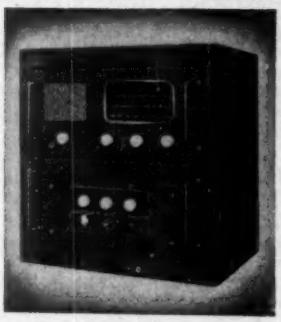
Work is proceeding on the interpretation and classification of typical patterns in terms of their aural effects. One approach has been to introduce elements of known acoustic properties into an echo-free room and to observe the distortion of the uniform pattern of practically vertical sound decay curves which is characteristic of highly absorbent test chambers. Fig. 2 shows the effect of a single Helmholtz resonator under these conditions.

The complete apparatus for acoustic tests of studios was shown recently at the open day of the Kingswood Warren Research Department of the B.B.C. It includes, in addition to the new pulsed gliding tone method, a rotatable graticule for giving direct readings of average reverberation time from the slope of the decay curve displayed on the c.r. tube, and circuits for short-pulse investigation of echo patterns. For ease of transport, miniature components have been used wherever possible and the equipment has been subdivided into units measuring 17in × 10in × 6in. There are six of these and the oscillograph, which is slightly larger.

Fig. 2. Disturbance of response of an echo-free chamber by the introduction of a single Helmholtz resonator.



New TRIX Quality SOUND EQUIPMENT



ENCLOSED RACK EQUIPMENT

For medium powered installations, incorporating 20 to 30 watt amplifier unit, radio receiver with monitor speaker. It can also be supplied with gramophone unit incorporated. Provision for microphone input and multiple speaker matching.

HIGH FIDELITY MICROPHONE

Model G7808, moving coil type. New design, neat and unobtrusive, in die-cast alloy casing. Fitted with switch and plug and socket connection.

"INTERVOX" INTERCOM.

Inter-communication equipment of entirely new design. Master unit in exceptionally compact walnut cabinet with facilities for each sub-unit to call back with audible and visual signal. Push button operation.

Full details of these and other models in the large Trix range of Sound Equipment available on request. Send for latest catalogue and price lists.

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AMPLIFIERS · MICROPHONES · LOUDSPEAKERS

RANDOM RADIATIONS

By "DIALLIST"

At the Show

KEEPING UP my proud record of having attended every major Radio Show in this country since the first held long ages ago in the Horticultural Hall (except that of 1939 when I had "gone for a sodger"), I duly clocked in—or clicked in—at the turnstiles at Earls Court on the preview day for a first look round. I like Earls Court. It is easy to get to and it seemed to provide more space for the stands than there has been in the past. I have never enjoyed myself more at a Radio Show.

A Good Sign

One's first general impression was that cut-throat, cut-price competition had been abandoned, let's hope for good. There were, in fact, few examples (if any) of a type of receiver that has been over common at times in the past: the one designed on the lines that quality, finish, factor of safety in components and so forth do not matter two hoots so long as the thing works and is cheaper than the next man's. Many of the best firms have, of course, never descended to this kind of thing and it is encouraging to see that their good example has at last forced the rest into line. The goods on show this year were such that the radio industry and the country could be proud of them without "ifs" and "buts." First impressions were confirmed by more detailed examination and by talks with exhibitors. Wireless and television are now where they should always have been, in the class of semi-luxuries, though not unduly expensive ones.

The Bigger Picture

With the exception of one bedside miniature television set, those seen at the Show gave evidence of a tendency towards larger images. I doubt whether there will be more than a handful next year with tubes smaller than the twelve-inch, which is so much to the fore now. Sixteen, twenty, and even twenty-one inch tubes were to be seen at Earls Court, though I was rather surprised to find spot-wobble used with so few of the larger sizes. The other school of thought in the matter of bigger pictures backs the small, super-brilliant tube and projection by means of a lens system. As things are, I am rather inclined to be a projectionist, for, with purchase tax at its present iniquitous level, the outlay that may possibly be necessary to replace a broken down c.r.t. of large size is rather frightening. There may be a little less depth in a projected image and possibly it is not quite so sharp as a direct one; but this system does bring the big picture within the range of the citizen of moderate means.

GREAT AND SMALL—The largest and smallest cathode-ray tubes at Earls Court. The H.M.V. receiver employing a 21-in tube compared with a miniature set incorporating a one-inch cathode-ray tube.

Puffs and Things

INGENIOUS though it is, I am afraid I cannot support A. C. Kay's suggestion (Letters to the Editor, August, p. 321) that the picofarad or "puff" should be made the basic unit of capacitance. It is open to the same objection as the farad: if the farad is much too big, then the puff is much too small to fit nicely into the general scheme of the extended metric system in use to-day. In that system the basic unit is normally something of medium size, capable of being multiplied usefully by 10, 10^2, 10^3, etc., or 10^{-1}, 10^{-2}, 10^{-3}, etc. Thus kilogram and milligram, megawatt and microwatt, kilometre and millimetre are all useful quantities, based respectively on the gram, watt and metre. But a micropuff or even a millipuff seem as little likely to be encountered in any electrical or electronic calculation as a megafarad or a kilofarad! What we seem to want is a basic unit equal in value to the present microfarad. How about the capital "C"? Then a farad = 1 MC and a puff = 1 μC. There's not much difficulty about typing μ, by the way. Just type a small "u" and lengthen the first downstroke when correcting the script. Americans don't even bother to do that. They write "50 uuF"!

Is the Pentode Innocent?

A LANCE, I feel, must be broken with that doughty champion of the pentode, Thomas Roddam. I agree wholeheartedly that, as he states in his letter in the August issue, it is not the car but the driver that does the killing. Nevertheless, I cannot help thinking that Aunt Jane is far less of a menace to life and limb when driving her battered "Seven" than she would be at the wheel of a super-sports speed model. With the pentode the stage gain is as nearly as makes little matter $g_m \times Z_a$; in the output stage Z_a is mainly inductive reactance, whose value rises with the frequency. Owing to its enormous amplification the pentode is something akin to the sports model car and with a not-so-hot designer as the Aunt Jane in charge of its circuitry it becomes a menace to good quality by producing a rich crop of odd-numbered harmonics, horribly amplified. To some designers negative

feedback is the panacea for every ill. Too often it is misused, with dire results. I agree that with good design and the use of suitable components the pentode can be rendered almost distortionless; but even if the designer of a commercial broadcast receiver knows how to bring about this desirable state of affairs, his style may be cramped by considerations of cost. Hence the pentode, as the wet-nose listener knows it, is apt to give a performance that pains the ear—unless the tone-control knob is turned far enough anti-clockwise to produce the mellowness favoured in so many homes to-day. Unpleasing though it may be to the lover of good quality, such mellowness is not so distressing as shrillness.

"*Triodophile*"

Is one to gather that Thomas Roddam regards all users of the triode as reactionaries? If so, I am a reactionary, for I confess, frankly, to a liking for a pair of matched triodes in Class A push-pull in the output circuit. As a *triodophile* I am not in bad company. Valve makers have developed not a few special types for v.h.f. work and no fewer than sixteen triodes in the output of the modulator and the final amplifier of the B.B.C.'s newest medium-wave station help to bring the Third Programme to T.R.'s aerial.

No Dull Uniformity!

SOME TIME AGO I mentioned, rather wearily, that lack of international standardization extended even to such things as mathematical signs. One example that I then gave was the Continental habit of using commas where we and the Americans put stops and stops where we have commas in writing or printing numbers. In most Continental countries, for instance, 10^3 is written as 1.000 and 10^{-3} as 0,001. I have just come across an even more remarkable divergence from what I hoped and believed was accepted practice. In an article in a Danish publication I was startled to see something like:

$$2\,(x+y)+y=2x+y.$$

The writer clearly meant "minus" and not "divided by." Printer's error, I thought, and passed on—only to meet a few lines later the weird looking sign $\frac{+}{\div}$! In other articles the minus sign was always ÷. I do not know whether this is the normal practice in Denmark, but if it is, it must be confusing for any student who dips into a foreign text book.

THE CHOICE OF CRITICS

A comprehensive range of Crocodile-clips, designed for a wide variety of uses.

Jack-plug. Excellent for use with microphones, telephones, and loud-speaker connections.

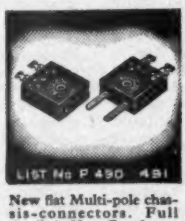
Telephone-type Signal lamp holder. Takes flat-contact "telephone-jack-lamps."

Now known as List No. S.270/SD. Slotted dolly for mechanical operation. Two-pole, change-over switch.

Now known as List No. S.271/PD. Biased to **OFF**, fitted with Pear-dolly silver-plated terminals for connection.

Semi-Rotary Q.M.B. Snap switches. Many other similar types are available. Knob is extra.

Thermal-Flasher Switch. Ideal for use with Bulgin Signal-lamps for use as warning or indicator.



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Single-pole fuse-holder. Silver-plated contacting members, insulation is of the highest grade S.R.B.P. or -F.

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BYE-PASS ROAD BARKING
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Bottled Broadcasts

I HAVE been asked by an acquaintance to advise him on the best way to spend £80 and I should like your help. But in order to forestall facetious suggestions from any of you with low leanings toward beer and blondes, I had better state at once that I am speaking in all seriousness and should greatly value your counsel.

Briefly, my acquaintance, who already possesses a first-class radiogram, is desirous of spending a further £80 or so to improve his radio enjoyment. He is a commercial traveller and therefore keeps rather irregular hours—no coarse comments please—and quite frequently misses his favourite programmes. He is, therefore, inclined towards spending the money on a time switch and a tape recorder so that he could preset the apparatus to bottle his favourite programmes during his enforced absences from home.

His family, however, is anxious that he should spend the money on a television set, since they are always at home and have, therefore, no need of bottled broadcasts. Unlike many commercial travellers he does spend some of his evenings at home and so he too, as well as the family, would enjoy the television programmes. But, putting aside all question of his plain duty to his family, he cannot decide which piece of gear would bring the greatest enjoyment to him personally.

He could, of course, for conscience sake, buy a comparatively inexpensive television set and spend the balance of the cash on parts to construct a magnetic-tape recorder. But, quite frankly, he has neither the time nor inclination for home construction, and, as £80 or so is his limit, he certainly cannot have both pieces of equipment. The question is, therefore, which shall it be? In the words of the late Syd Walker, "What would you do, chums?"

Beer and Blondes.

Televentriloquism

THE success of ventriloquism depends on subtle psychological suggestion coupled with the ability to speak without moving the lips, skill in which some of you may, like myself, have acquired when serving in what has been aptly described as "His Majesty's Other Service." The voice certainly seems to come from the ventriloquist's dummy, the illusion being greatly assisted by skilful manipulation of its lips and limbs. Of course, subtle psychological suggestion by itself is really all that is necessary as is amply demonstrated by the Brough "Educating Archie" broadcasts, but, nevertheless, visual aids and labiostatic speech help a lot.

The powerful principle of suggestion also plays a tremendous part in enabling us to enjoy the television programmes, for, by its means, voices and other sounds do seem to come from the screen even though we know very well that they are coming from the adjacent loudspeaker. There is, however, a limit to the distance between c.r. tube and loudspeaker over which this suggestion process works. There is the same limit to the permissible distance between a ventriloquist and his dummy quite apart from the necessity of having it in a position where he can manipulate it.

I see, however, that according to one of the many American magazines devoted to "popular" science—and you know what that implies—the ventriloquist's distance - limitation problem has now been solved. The method employed is ingenious but in my opinion unnecessarily complicated. The innards of the dummy in this newly invented televentriloquial system consist of a magnetic tape recorder, amplifier and loudspeaker. Prior to the performance the ventriloquist records in his ventriloquial voice the backchat and repartee to which he wishes the dummy to give utterance; gaps are left in the recordings for him to put in his own part of the dialogue during the actual performance. All that remains, therefore, after the apparatus has been switched on and the show started, is that the performer should carefully time his utterances to fill in the gaps between the dummy's mouthings.

Surely it would be far simpler to employ the method which I have used for many years when giving a ventriloquial turn in the village hall but have hitherto thought too trivial an "invention" to talk about. A small battery-operated decimetre-wave transmitter is distributed about my person with the microphone strapped around my midriff. My dummy, of course, houses a receiver and loudspeaker. Its lip and limb movements, as well as its voice, are also operated radio-telearchically. In the latter part of the idea I must certainly claim no originality as my system of control was evolved from the series of articles on radio-telearchics published in this journal as long ago as 1926.

H. M. Other Service.

Musical Murder

MANY people beside Mrs. Free Grid and myself must feel annoyed when at the end of a broadcast talk which has been coming from the loudspeaker at pleasantly audible volume a nerve-shattering roar heralds the beginning of a musical item. Many of us who are steeped in musical Philistinism, and content to remain so, and who care as little as Gallio for scale distortion and suchlike things, often wonder why the B.B.C.'s control engineer doesn't turn the wick down when musical items start and so keep the average volume from our sets on an even keel; if I may be permitted to mix my metaphors. But to do so, of course, would be unfair to music lovers who like their favourite fare faithfully rendered as in the concert hall. But is there any reason at all why the B.B.C. should not accompany broadcasts of music with a special signal—occupying minimum bandwidth—which would actuate an electronic music-muffling relay fitted on our sets? The principle is already used in the American cackle-cutting service about which I wrote in the August issue. Music lovers would, of course, simply switch off the relay.

CRAFTSMANSHIP

"I can most certainly say at this stage that the workmanship and finish are of a quality which I have never before encountered in the radio industry, despite the fact that my association with the industry in one capacity or another extends back over 27 years. I think you are to be congratulated all the more on this achievement in view of the increasing tendency nowadays towards inferior workmanship and design."

Part of a letter from a purchaser who is a very well-known engineer and whose identity is known to the Editor of "Wireless World."

"POINT ONE" AMPLIFIERS

NEW RC/PA/U
REMOTE CONTROL PRE-AMPLIFIER
PRICE: 9 GUINEAS

"POINT ONE" TL/12 12 WATT
TRIPLE LOOP FEEDBACK AMPLIFIER
PRICE: 27 GUINEAS

APPLICATIONS

1. For laboratory use as a stabilised-gain audio-frequency power amplifier.
2. For the highest possible standard of disk recording.
3. For the highest possible quality of reproduction from Pickup, Radio, Microphone, Film and Magnetic Tape.
4. For use as a driver amplifier in the speech modulator chain of broadcast transmitters.
5. Used with the RC/PA/U pre-amplifier and the best available complementary equipment the TL/12 power amplifier gives to the music-lover a quality of reproduction unsurpassed by *any* equipment at *any* price. It is designed in a form so that the power amplifier can be housed in the base of a cabinet and the small pre-amplifier mounted in a position best suited to the user.
6. The pre-amplifier and the power amplifier are drilled for bolting together to make a single transportable unit. A cover with a carrying handle is available for this unit, and assembled in this form the equipment is particularly suitable for lecturers and for Public Address work where very high quality of reproduction is essential.

The New B.B.C. Monitor loudspeaker uses a Leak TL/12 amplifier. 731 TL/12 amplifiers were ordered by broadcasting authorities during 1950, including :—

The British Broadcasting Corporation.
The South African Broadcasting Corporation.
The Swedish Broadcasting Corporation.
The Swiss Broadcasting Corporation.
The Italian Broadcasting Corporation.

The "POINT ONE" TL/12 and RC/PA/U AMPLIFIERS are built to a tropical specification and they are distributed throughout the world. During 1951 to date (May, 1951) orders totalling over 2.000 have been received from the U.S.A. for RC/PA/U and TL/12 amplifiers for high quality radio/gramophone reproducers for the home.

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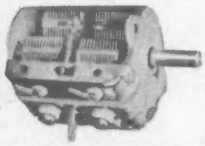


2-GANG .00035 TUNING CONDENSER

Complete with perspex dust cover and built-in trimmers. Super job for tuning personal receivers, **8/6** each.

EX-ROYAL NAVY SOUND POWERED TELEPHONE

These require no batteries, and will go for long periods without attention. Complete with generator and sounder which gives a high pitched note, easily heard above any other noise. Also fitted with an indicator lamp which in quiet situations can be used instead of the sounder, or where several 'phones are used together will indicate which one is being called. Size 7½in. × 9in. × 7½in., wall mounting, designed for ships' use, but equally suitable for home, office, warehouse, factory, garage, etc. Price **37/6** each, plus 3/6 carriage.

TRIP SWITCHES

In addition to the many industrial uses, these trip switches are useful additions to your laboratory and workshops. Fitted into the power circuit like a normal switch they can in the first place be used to control the power outlets and when as often happens a short circuit occurs, instead of the fuses blowing, the switch will simply trip and will not close again until the short is cleared. The actual current at which the switch trips can be adjusted. Price **12/6**.

12-CELL ACCUMULATOR

This accumulator can be coupled up to give 24 v. with all cells connected in series or 12, 6 or 2 volts by series parallel arrangements. They were originally made for the Admiralty by a leading manufacturer, have never been filled, and are in excellent condition. Each is contained in a wooden crate as illustrated. Price **27/6** each. Postage and insurance 5/-.

SPECIAL PERSONAL SET OFFER

Resulting from the changeover of a famous manufacturer to important work, we are able to offer practically all the parts for the really neat personal radio illustrated.

The most important thing of course, is the cabinet and for this we can offer a complete kit of parts, which includes cream plastic lid, base and escutcheon, crackled metal body and all accessories such as knobs, hinges, lid arm and clips, etc.

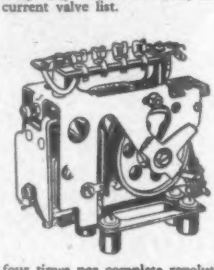
Price **22/6**, but remember this brings the complete cabinet size 7×4×3½in. Other items available are :—

Metal Chassis. Five-part assembly comprises the main chassis and sections for holding the batteries and the loudspeaker. Price **4/6**. Ditto with four B7G valve holders already riveted in their correct positions. Price **7/-**.

Frame Aerial, 3/6.
Oscillator Coil, 3/6.
I.F. Transformers, Wearite Midget type 400B, **15/-** pair.
Volume Control, 1 meg. Midget, **3/6.**
Speaker, Midget Plessey 3in., **14/6.**
Output Transformer to match, **5/-.**
On/Off Switch, lid operated, **1/6.**
Resistors, miscellaneous, total 8, **4/-.**
Condensers, miscellaneous, total 9, **4/6.**
B7G Amphenol Valve Holders, 8d. each.
Tuning Condenser, 8/6.
Assembly Instructions, including wiring diagram and alignment data **2/6.**

Note.—All these parts are offered separately. Valves required are IR5, 1T4, 1S5, 3S4 or 3V4, all available at low prices, send for our current valve list.

REMOTE CONTROL



With only one pair of wires and a simple push button you can select any one of four stations without leaving your armchair. This is just one of the many applications of our impulse relay, the price of which is only **3/9.** There are many other purposes to which it can be put we will supply a booklet of circuits for **1/9** post free. The action of the impulse relay is as follows :— current to the solenoid causes the ratchet wheel to rotate one notch per impulse, a built in automatic switch keeps the impulses coming in until they are switched off by secondary contacts which operate four times per complete revolution. Shorting the secondary contacts starts the impulses again. Attached to the ratchet wheel is a four way single pole switch. We are sure that there are many new applications for this relay and we offer prizes for new ideas.

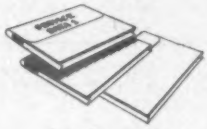
MAINS/BATTERY PORTABLE

Ultra modern cabinet, highly suitable for making up an all-mains and/or all-dry battery receiver. Cabinet dimensions, 7½in. deep and 10½ in. high × 12in. wide. Imitation crocodile cabinet with back and wooden platform, battery dividers, inner front drilled for three controls, and handle, **22/6** complete.

Ivory Fret with Perspex Window, loud speaker louvres and turning scale, **5/6.**
Frame Aerial wired for long and medium wave with plug board and tag strip, **5/6.** Unwired, **2/6.**
Metal Chassis punched out and with loudspeaker cut out, **5/6.**
Assembly for holding dial and lamps, **1/9.**
Matched Knobs, set of 3, **2/-.**
Or all items unwired frame aerial, **38/6**; wired frame aerial, **42/6.** Wiring diagram and constructional details, **2/6.** All components available (total cost of set should not exceed **£7/10/-.** For details, see constructional data.

TIMED SWITCH MECHANISM

This comprises a beautifully made 8 day jewelled miniature watch movement, which operates two 2 amp contact switches. These switches also are quite suitable for mains use. There are two calibrated dials, one contact adjusts in ¼ hour intervals up to 6 hours, the other one in one hour intervals up to 36 hours. The whole is really precision made to stringent M.O.S. specification. The size of the complete switch mechanism is 3in. long and 2½in. across. Or if you wish, the miniature clock movement can be removed completely and this then measures only 1½in. × ¾in. The price of the complete timed switch is **27/6.** These are brand new still in the manufacturers original sealed boxes.



SERVICE DATA

100 service sheets, covering British receivers which have been sold in big quantities, and which every service engineer is ultimately bound to meet. The following makers are included : Aerodyne, Alba, Bush, Cossor, Ekco, Ever-Ready, Ferguson, Ferranti, G.E.C., H.M.V., Kolster Brandes, Lissen, McMichael, Marconi, Mullard, Murphy, Philco, Phillips, Pye, Ultra. Undoubtedly a mine of information invaluable to all who earn their living from radio servicing. Price **£1** for the complete folder.

Our folder No. 2 consists of 100 data sheets covering most of the popular American T.R.F. and superhet receivers "all dry" etc., which have been imported into this Country. Names include Sparton, Emmerson, Admiral, Crosaley, R.C.A. Victor, etc. Each sheet gives circuit diagrams and component values, alignment procedure, etc., etc. Price for the folder of 100 sheets is **£1.** Post free.

MISCELLANEOUS BOOKLETS

These give circuit diagrams and details of Ex-Government receivers and equipment. In practically all cases the information has been extracted from official publications. Separate booklets for each piece of equipment. Booklets available covering the following :—R1155, R208, R109, TR1196. TR18, BC348, BC312, R1116, R107, R103, BC221, BC342, Pre-Amp. from RF27, Pre-Amp. from Unit 208A, T.V. Receiver from 1½-metre superhet for London or Birmingham, T.V. receiver from 3170, etc. T.V. receiver from 194 strip. Dual band T.V. receiver. Price of any of these booklets is **1/6** each—all post free.

"SNIPERSCOPE"

Famous wartime "cats eye" used in conjunction with a lens system and h.t. for seeing in the dark. This is an infra-red image converter cell with a silver caesium screen which lights up (like a cathode ray tube) when the electrons released by the infra-red strike it. It follows that as light from an ordinary lamp is rich in infra-red these cells will work : burglar alarms, counting circuits, smoke detectors and the hundred and one other devices as will the simpler type of photo cell. Here then is a golden opportunity for some interesting experiments price **9/6** each, or six for **52/6.** Data will be supplied with cells if requested.

HIGH VOLTAGE CONDENSERS

We have many types in stock, one special one at a low price is .01 mfd. 5 kV. in 5in. Ali-can, **2/6.**

BREAK-DOWN UNIT

At present-day prices the spares in this unit would cost at least £5: Here is a list of the main contents.

3 two-metre coils ;
3 tuning condensers, split-stator type ;
4 two-watt carbon resistors, useful values ;
1 tapped 20 watt resistor, vitreous covered ;
6 paper condensers, .05 mf. 1,000 v. working.
3 paper condensers, .1 mf. 1,000 v. working ;
2 H.F. chokes ;
4 paper condensers, .1 mf. 450 v. working ;
2 paper condensers, .15 mf. ;
5 bakelite moulded mica condensers .001 ;
1 paper condenser, .01 mf. 3,000 v. working ;
24 rubber grommets, assorted sizes ;
6 resistors, 1 watt, all useful values ;
6 resistors, ½ watt, all useful values ;
40 resistors, ¼ watt, all useful values ;
40 silver mica condensers assorted values, including : 10, 15, 20, 40, 50, 100, 150, 300, and 500 pf. types ;
4 English octal valve holders ;
2 English 5-pin valve holders ;
1 E.F. 50 type valve holder ;
3 diode valve holders ;
1 louvred casing, size 12 × 7 × 4in. ;
1 heavy metal chassis size 12 × 7 × 2in. ;
8 condenser clips, assorted sizes.

Also an assortment of nuts, bolts B.K., self-threading screws, tag boards, chassis mounting tag connectors, screened grid caps, plain grid caps, levers, rollers connecting rods, output sockets, etc., etc. ALL THIS COLLECTION OF PARTS FOR **6/6** only plus 1/9 postage and packing.

HOT AIR BLOWER

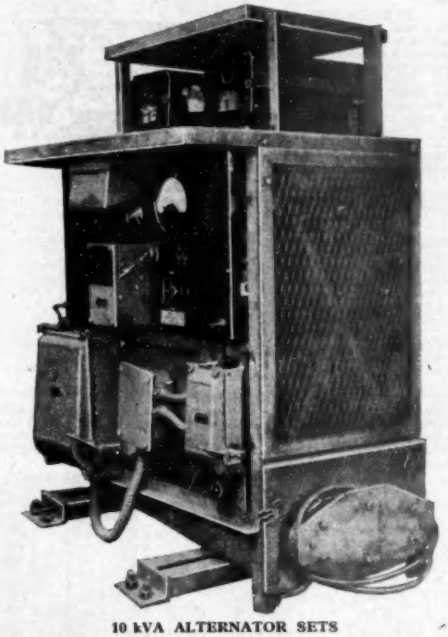
For drying out instruments, etc. This is an attachment which is fitted with a mains operated heating element and heat control, it is designed to fit on a vacuum cleaner tube at the blowing end of course. Price **17/6.**

CLEAR PERSPEX PANELS

Size 5½in. long, 3½in. wide, and a little over a ¼in. thick. Price **1/6** per panel.

EXTENSION SPEAKER IN METAL CABINET

This has a 6½in. P.M. Goodman's Speaker, heavy magnet type, complete with an output transformer. It is fitted in grey steel case with perforated front and back, ideal for P.A. work in canteens, clubs, etc. **27/6** each.



10 kVA ALTERNATOR SETS

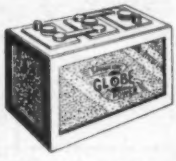
Complete electrically with all switch gear, voltage regulators, frequency meters. etc., etc. These have two circuits, one giving 10 kVA. at 230 v. 50 cycles, the other giving 1½ kVA. 230 v. 500 cycles. Complete with 'Vee' belt pulley. Can be driven by lorry engine, oil engine, etc., the speed of which is not important. Unused but somewhat storage soiled. Price **£65**, carriage extra.

"OCCASIONAL 4" CABINET

Attractive bakelite cabinet, size 12in. × 5in. × 6in., suitable for making a T.R.F. or superhet receiver. Price with back **17/6**, in walnut, green or ivory. Post and insurance 2/6. **PUNCHED METAL CHASSIS** T.R.F. for three valves and rectifier, **5/6.** Superhet for four valves and rectifier, **5/6.** **ENGRAVED GLASS DIALS** 16-50 and 180-550 metres, **2/6.** 180-550 and 800-2,200 m., **2/6.** 16-50, 180-550 and 800-2,200 m., **2/6.** Dial back plate, **2/6.** **COILS** T.R.F. 180-550, 800-2,200, **5/6** per pair. Superhet 16-50, 180-550, 800-2,200 metres, **10/6** per set. **CORD DRIVE ACCESSORIES** Drum 2½in. dia., **1/6.** Driving head, **1/6.** Double Pointer, **4d.** Spring, **3d.** Nylon Cord, **6d.** per yard. A set can be built into this cabinet for less than £6, constructional data, **1/6.**

6-VOLT AMERICAN HEAVY-DUTY BATTERIES

Made by one or other of the most famous American battery companies. For reliability and long service between charges these are in a class of their own. Capacity rating is 140 amp-hour. We have a limited quantity of these batteries available, unused—in fact they have never been filled with acid, and the price is **£5/10/-**, carriage extra at cost depending upon your locality.



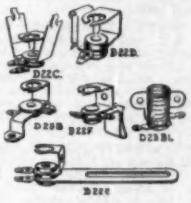
Orders received by pen are dealt with from our Ruislip depot, therefore, avoid delay by sending your order direct.

TWO-VOLT ACCUMULATORS

Made for the Forces by one of the most famous firms in the world. 15 amp.-hour size approx. 6in. × 1¼in. square in ebonite case, pre-charged, only need filling with acid, **5/9** each, plus **1/3** post and insurance. Six or more post free.

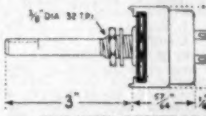
LAMP HOLDERS

We carry a large assortment of dial lamp holders. Price 1/3. each. Order by list numbers.



15 AMP. DOUBLE POLE ROTARY SWITCH

Made by the famous Diamond H Company, it is complete with pointer knob. Price **5/6.**



VOLUME CONTROLS

We carry a full range of standard-size volume controls from 2K, to 2 meg. Prices are : less switch, **3/-** : Single pole switch, **4/-** : double pole switch, **5/-**. We can also supply midget-type controls, less switch, **4/-** : single pole switch, **5/9** : double pole switch, **6/6** : Each of these midget controls has a serial number and carries a 12-month guarantee by the makers; they are made on the new moulded track principle and really do perform well.

SPRAY GUN

Hand operated, ideal to put the finish on a good chassis, and for respraying valves, etc. (completes the perfect job). Price **15/6**, complete with instructions plus 9d. postage.

Orders under £2 add 2/6, under £1 add 1/9. Postable items can be sent C.O.D., additional charge approx. 2/6 List 6d. Early closing days: Wednesday, Ruislip ; Saturday, City. **Telephone: Ruislip 5780.**

ELECTRONIC PRECISION EQUIPMENT (2)

152-153 FLEET STREET, E.C.4.

42-46 WINDMILL HILL, RUISLIP MANOR, MDX.

ELPREQ PAGES

TOGGLE SWITCHES

Metal body standard size, made by our leading maker. Available with round dolly or with special V cut dolly. State which type when ordering. Price while stocks last only **1/6** each.

MICRO SWITCHES

Leaf type **3/6**. Rubber plunger type **3/6**. Ball type **3/-**, in stock. Other types may be available from time to time.

3½ WATT AMPLIFIER KIT

An A.C. mains operated 3-stage amplifier on metal chassis. Suitable for use with pick-up or microphone, etc., output impedance 3 ohms. Price **£3/9/6**, plus 2/- post. Bakelite cabinet for same, with back, **17/6**, postage and insurance 2/6. Constructional Data 1/6.

ARMOURED PLATE GLASS

Made for use on T.V. sets in front of the Cathode Ray Tube for 10in. or 12in. tubes :—

Size 14¼in. × 11¼in.	5/-
Size 13in. × 10¼in.	4/-
For 6in. or 9in. Tubes :—	
Size 9¼in. × 8¼in.	3/-
Size 8¼in. × 9¼in.	3/-

RUBBER MASKS FOR T.V. SETS

6in. Mask	8/6
9in. Mask with glass	10/-
,, ,, less glass	7/6
12in. Mask	15/-

R107 MANUALS

We have a small quantity of the original instruction manuals as issued by the Army, at **12/6** each.

SELENIUM RECTIFIERS

Suitable for car battery chargers :—

6 v. 1 amp.	5/-
12 v. 1 amp.	9/-

R.F. E.H.T. UNITS

Why keep replacing E.H.T. mains transformers, our R.F. E.H.T. Units will give up to 6 K.V., it is non-lethal and trouble free. Size is 4¼in. × 3¼in. × 4in. Complete and ready to operate **79/6**

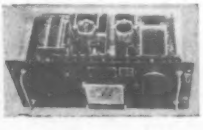
GRAMOPHONE UNITS

These Units are a 78 R.P.M. type, made by a very famous maker. They comprise a centre drive induction motor with speed regulator, auto. stop and magnetic pick-up, all mounted on a full size unit plate. Price **£5/5/-** each, plus 3/6 extra for packing and insurance.

Although supplies of auto-changers and other types of Gramophone Units are rather erratic, it is very seldom we have not something in stock, so why not pay us a visit.

C.R. TUBE BARGAIN

E.M.I. Cathode Ray Tube, type No. 4/1, electrostatic 3in.—complete with tube holder—unused and guaranteed perfect. Price **9/6**, postage, packing and insurance 2/6 extra.

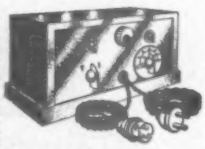


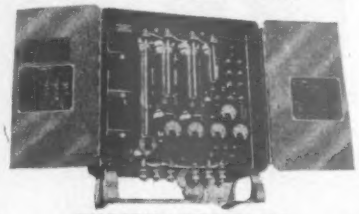
TUNING UNITS

American made units available are TU5B, TU6B, TU9B, TV10B, TU47, TU52, TU60. All **19/6** each, plus 3/6 carriage.

ELECTRONIC TIMER

With this instrument processes which operate over a specified time can be controlled automatically, e.g., in photography use it to control time exposures, etc. The instrument can be set to any length of time from a fraction of a second up to 3 minutes, and it can be made to switch the appliance on or off. Circuit diagram and instructions **2/3**. Complete kit of parts including valves, mains transformer, power pack sensitive relay, potentiometer and metal case, **69/6**.





CHARGING SWITCHBOARD

This 550 watt 18 volts charging board is fitted into a steel case with doors and it comprises, three reverse current relays (cut-outs) one voltmeter, one main ammeter, two secondary ammeters, and three variable resistances for controlling load circuits—brand new in original cases **£6/10/-**, carriage 10/- extra.

VALVEHOLDERS

Type	Paxolin	Amphenol	Ceramic
	s d	s d	s d
British 4-pin	6	—	9
British 5-pin	6	—	9
British 7-pin	6	—	9
British 9-pin	9	—	—
UX 4-pin ...	6	—	1 6
UX 5-pin ...	6	—	9
UX 6-pin ...	7	—	—
UX 7-pin ...	8	—	—
Large UX7	—	—	1 0
Diode B3G	5	8	—
B7G ...	6	8	10
B8G Loctal	9	—	—
B8A ...	1 3	1 6	—
B9A (Noval)	1 3	—	—
B9G ...	1 0	1 0	—
B12A (Duodecel)	1 3	—	—
Int. Octal ...	6	9	1 6
Mazda Octal	6	9	—
8-pin side Contact ...	—	2 6	—
Jumbo 4-pin	—	—	3 6
4-pin Hivac	9	—	—
5-pin Hivac	9	—	—
5-contact Acorn ...	—	—	1 6

VALVE SCREENING CANS

	s d
Suitable for standard size valves consists of three parts, bottom plate, main body and spring top	1 3
B7G fixing base and top screen with spring	1 6
Screen for octal G.T. Valves...	6

VALVE RETAINERS

Spring type for EF50 ...	3
Threaded type for EF50 ...	6
General type for all valves, consists of a silk cord and two springs	3

VALVE TOP CONNECTORS

Type	Plain	Scr'ned	Insulated
	s d	s d	s d
British ¼in. top ...	1½	9	1 6
American ¼in. type ...	1½	9	1 6
Screw to clip adapter (for modern equivalents)			6

TRANSFORMER SNIP

A Universal replacement by a very famous maker. Standard mains input secondaries : 350-0-350 at 80 mA. 6.3 tapped at 4 v. 4 amp. and 4 v. at 3 amps. Special price for one month only **10/6** plus 1/- post. Note this is a half shrouded drop through type.

50 AMP. TRANSFORMERS

Suitable for low voltage soldering irons, ground heating, welding, etc. Weight approximately ¼ cwt. Size 7½in. × 7in. × 6in. The voltage tapping is between 13 and 15 volts with an input of 200-230 v. 50 cycles. Price **£3/15/-**, carriage and packing 17/6.

FILAMENT TRANSFORMERS

200-240 v. Mains Input, 6.3 v. 1½ amp. output. Ideal for instruments and small receivers, etc. Price **6/9**.

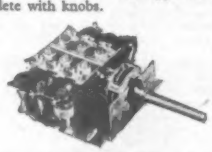
200-240 v. Mains Input, 2 v. 2½ amp. output, highly insulated for T.V. tubes, etc. Price **7/6**.

MULTI-VOLTAGE TRANSFORMER

Made by one of our famous companies, no less than 140 different voltages can be obtained from the mains varying from 5.5 v. to 339 v. Price only **9/6** each.

PUSH BUTTON SWITCH UNITS

Four push type with one for mains ON/OFF **2/9**. Three push type wave change only **2/3**. Both types complete with knobs.



"ELPREQ" 3-WAVE BAND COIL PACK

This is a really first-class pack, the performance of which is far superior to many more expensive types. You can use this (a) if you are building a superhet receiver (all your alignment worries are over) or (b) if you have an old superhet receiver of which the coil and oscillator sections have been butchered, the pack can make repairing easy.

Specification : long, medium and short waves with iron dust cored coils, I.F. 465 kc/s. Size 3in. × 3¼in. × 1¾in., spindle length of wave change switch 1¼in. Guaranteed pack complete with circuit diagram, **29/6**.

STOP PRESS

Good news for battery set users. You can now recharge your dry H.T. batteries. New unit saves its cost many times over. Price Radio Model **£3 5s.**, Hearing Aid Model **£4 4s.**

MILLIBAR BAROMETER

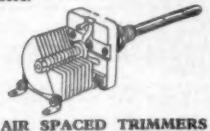
If you are interested in meteorology, or if you think a good barometer would help you to explain some tricky radio problem, then you will be interested to know that an article appeared in one of the leading meteorological journals, showing how the Ex-R.A.F. Sensitive Altimeter can become a first-class highly sensitive yet robust aneroid barometer. We offer the sensitive altimeters in good condition with instructions at 17/6 plus 1/- postage.

CABLE CLIPS

These cable clips are carefully made for the Navy and are designed so that the edge of the clip cannot cut into the insulation of the cable. In addition to their use for holding cables, these clips are also suitable for fixing back conduit, for fixing T.V. aerial masts to poles or window frames, etc. :—

Depth of Saddle (inches)	Across Saddle (inches)	Admiralty No.	Price each
2	7⅛	7,000	9½d.
	7⅛	7,087	8d.
	3⅛	3,350	7d.
1⅛	6⅛	7,001	8d.
	3⅛	7,086	6d.
1⅛	8⅛	7,005	10½d.
	8⅛	7,003	10½d.
	6⅛	7,002	8d.
	6	7,091	8d.
	3⅛	3,354	5d.
	3	7,090	5d.
1⅛	5⅛	7,004	6d.
	3⅛	7,088	5d.
1⅛	5	7,095	6d.
	2⅛	7,094	3d.
	1⅛	7,083	2d.
1⅛	6⅛	7,008	8d.
	5⅛	7,099	4d.
	2⅛	7,006	3d.
1	4⅛	7,013	5d.
⅛	3⅛	7,016	4d.
	3	7,101	4½d.
	1⅛	1,100	2½d.
⅛	5⅛	7,106	6d.
	4⅛	7,102	5d.
	3⅛	6,105	5d.
	2⅛	7,104	3d.
	1⅛	7,103	2d.
⅛	1⅛	7,107	2d.
⅛	4	7,111	5d.
	3	7,110	3d.
	⅛	3,488	2d.
	⅛	7,112	1½d.

Special quotations to quantity users.



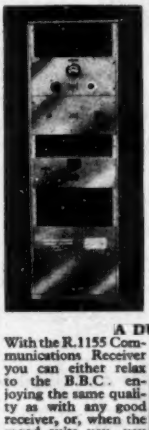
AIR SPACED TRIMMERS

We have a good assortment of air spaced trimmers. The one illustrated is a 30 p.f. with long (2½in.) spindle. Price 2/3. Another interesting one is a 2-gang 75 p.f. with short spindle. Price 4/9.

SOMETHING TO MAKE

Why not make a capacity-operated electronic switch. The operation is roughly as follows: a free-running oscillator is tuned by a length of wire which terminates in a small metal plate, a person or object passing close to this metal plate will de-tune the oscillator. This de-tuning will cause loss of auto-bias, this loss of bias will cause the anode current to rise which in turn will cause anode volts to fall. This change of voltage is amplified and used to trigger off a sensitive relay, the secondary contacts of which will light a lamp, ring bell or perform any other desired operation. The two most popular uses to which capacity-operated switches have been put are (1) as a crowd collector around shop windows where passers-by can switch on the shop-window lights simply by placing the hand over or near to the metal disc in the shop window. (b) As a burglar alarm in which case the metal plate is usually dispensed with and replaced by a length of concealed wire. This is certainly an interesting device, well worth making up. Circuit diagrams and instructions 2/3, post free. Complete kit of parts includes two valves, mains transformer, large and small condensers, sensitive relay, oscillator coil, valve holders, metal chassis and potentiometer, 69/6, plus 2/6 postage and insurance.

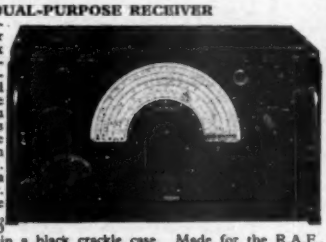
10,000 B.V.A. VALVES AT PRE-BUDGET PRICES



AMPLIFIER RACK

This stands approximately 6ft. high, and was made originally for the G.P.O. The top panel contains the amplifier proper, which consists of an A.C. mains-driven power pack, capable of delivering 200 mA. at 400 v. and, of course, the normal L.T. supplies, and the amplifier itself uses an MHL4 feeder and two PX25s in the output stage, giving approximately 25 watts. This top deck also contains the heavy duty output transformer. The lower panel contains the feeder unit which can be used as a pre-amplifier for microphone and gramophone work. You will observe that on the rack there is ample space for fitting a monitor speaker and an R.F. unit if same are required. Note that the anode current of the PX25 valve is monitored by a 2½in. flush meter. Further note that these amplifiers were made by the famous MARCONI company. Price complete as illustrated but less valves, unused and only very slightly storage soiled, is only £12/10/- each, plus carriage at cost.

A DUAL-PURPOSE RECEIVER



With the R.1155 Communications Receiver you can either relax to the B.B.C. enjoying the same quality as with any good receiver, or, when the mood suits you, you can don headphones and search out the weakest station on your favourite band. It is undoubtedly a dual-purpose receiver. Its frequency range is 75 kc/s. to 18 mc/s., complete with 10 valves and is fitted in a black crackle case. Made for the R.A.F., so obviously a robust receiver which will give years of service. We have available models as delivered from Ministry, used and untested, but complete at £6/19/6. If you cannot call to collect, please include an additional 10/- to cover cost of transit case and carriage. This is partly returnable to you if and when you return the transit case.

Orders received by post are dealt with from our Ruislip depot, therefore, avoid delay by sending your order direct to Ruislip.

ELECTRICAL INSTALLATION MATERIALS

In addition to our large range of radio accessories, we also carry a good stock of electrical wiring accessories, details of a few of these and of cables can be found below :—

T.R.S. CABLES, 250 v. CLASS

3/.029 twin flat, 1/4 yd.
3/.029 3-core flat, 2/- yd.
3/.029 twin, with earth, 1/8 yd.
7/.036 twin flat, 2/9 yd.
7/.029 twin flat, 2/- yd.
3/.036 3-core flat, 2/8 yd.
7/.029 twin, with earth, 2/4 yd.
7/.064 twin flat, 4/9 yd.

LEAD COVERED CABLES, 250 v. CLASS

3/.029 3-core, 2/3 yd.
3/.036 3-core, 3/8 yd.
7/.044 twin, 3/3 yd.
3/.036 twin, 2/- yd.
7/.099 twin, 2/9 yd.
7/.064 twin, 5/- yd.

WAR EMERGENCY TYPE CABLES 250 v. CLASS

These are P.V.C. or rubber insulated, laid flat then braided with cotton and compounded :

7/.029 3-core flat, 2/- yd.
7/.044 twin flat, 2/- yd.
7/.064 twin flat, 3/3 yd.

FLEXIBLES

Maroon gauge cotton covered :
23/36 twin twisted, at 8/- doz. yds.
P.V.C. 14/36 twin twisted, at 4/- doz. yds.
Twin flat P.V.C. for clocks, etc., 4/6 doz. yds.

MULTICORED FLEXIBLES

All are suitable for mains work as the separate conductors are very well insulated, then they are covered overall either with hard rubber, plastic or waterproofed braiding :—

10 core, at 2/6 per yd.
7 core, a. 2/- per yd.
5 core, at 1/- per yd.

CLIX 15 AMP. FOOT SWITCH PLUG

Made to B.S.S. specification, shuttered in moulded bakelite case, 8/6 each.

SLIDELOCK FUSES

15 amp., very latest pattern for mounting on the front of instrument panels, etc. Price 1/6 each.

"CRABTREE" SURFACE SWITCHES

Lincoln all brown No. 3000 one way. Price 1/11 each. Standard 1 way, brown on white No. 3010, 2/6. Standard 1 way double pole, brown on white, No. 3230, 4/-.

Orders under £2 add 2/6, under £1 add 1/9. Postable items can be sent C.O.D., additional charge approx. 2/6. List 6d.
Early closing days Wednesday, Ruislip ; Saturday, City.

Telephone : Ruislip 5780

ELECTRONIC PRECISION EQUIPMENT (2)

152-153 FLEET STREET, E.C.4.
42-46 WINDMILL HILL, RUISLIP MANOR, MDX.

BUILD A PROFESSIONAL RADIO OR AMPLIFIER AT LESS THAN HALF TODAY'S PRICE

You're SURE to get it at

STERN'S

ESTABLISHED 25 YEARS

ALL KITS INCLUDE "EASY TO FOLLOW" POINT-TO-POINT WIRING DIAGRAMS

A MAINS OR BATTERY PORTABLE KIT

A Midget 4-valve Superhet Portable Kit covering medium and long wavebands.
Designed to operate on A.C. mains 200/240 volts, or by an "Alldry" battery. The set is so designed, that the mains section is supplied as a separate unit which may be added at any time. The Kit therefore can be supplied either as an "Alldry" Battery Personal Set, or as a Midget Portable for combined Battery/Mains operation.
Circuit incorporates delayed A.V.C. and Pre-selective Audio Feedback. Kit is complete in every detail and includes ready wound frame aerials, fully aligned I.F. Transfs., and drilled chassis etc. Overall size of assembled chassis 8in. × 4in. × 2¾in.
We can supply the set either as a complete Kit of Parts for £8.16.9 (incl. P.T.) (less Cabinet and Mains Units), or by supplying the components separately. The complete Assembly Instructions, which include full price details (including prices of individual components), Circuit and Component Layout, etc., are available for 1/9 incl. postage.

A T.R.F. BATTERY "PERSONAL" KIT

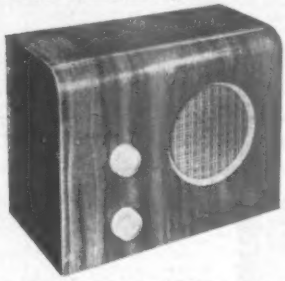
A complete Kit of Parts to built a Midget 4-valve Alldry Battery Portable Set, covering medium waveband.
Consists of Regenerative T.R.F. circuit, employing Flat Tuned Frame Aerial with Denco Iron Dust Cored Coil.
Valve line up. two I.T.4's (R.F. Ampl. and Det.), 185 and 384 output.
Kit is complete in every respect and includes drilled chassis, and latest type Rola 3in. P.M. speaker. Overall size of assembled chassis 4½in. × 2¾in. × 2¼in.
We can supply the Complete Kit (less cabinet) for £6.4.8 (inc. P.T.) or by supplying the components separately. The Complete Assembly Instructions, including individual component prices, Circuit and Component Layout, etc., is available for 1/-, incl. post.

A KIT OF PARTS

Complete in every detail, to build a 3-valve Amplifier for A.C./D.C. mains 200-250 volts.
Has an output of 3 watts, and incorporates a Tone Control.
Valve line up, 25A6, 6J7, U31.
Our price of £4.12.6 for complete kit, includes a matched 6½in. P.M. speaker.
This Amplifier can also be supplied assembled and ready for use for £5.12.6.

A MIDGET 4-STATION "PRE-SET" RECEIVER

A complete Kit to build a 4-Station "Pre-Set" Superhet Receiver for A.C. mains operation.
The Set is designed to receive any three stations on medium waveband and one on long waves, each station being received by the turn of a Rotary Switch—No Tuning being necessary.
It is of midget size, being 8½in. × 4½in. × 7in. high, and has the performance of a far more expensive ready made set, but can be built for half the price.



Price of complete Kit of Parts (including aligned I.F. Transf. and drilled chassis, etc.), £9.2.6 (incl. P.T.'s (plus Cabinet 25/6), or the components can be purchased separately. The complete Assembly Instructions including Individual Component Price List, Circuit and Component Layout, etc., is available for 1/9.

STERNS "RADIO TUNER MANUAL" Price 2/6. (Plus 3d. Post.) Contains complete and detailed assembly instructions showing how to make:—

★ **A 1 Valve T.R.F. Tuning Unit**, covering Long and Medium Wavebands.

★ **A 4 Station "Pre-Set" Superhet Tuning Unit**, producing 3 Stations on Medium Waveband and 1 on Long Waves.

★ **A 2 Valve Superhet Tuning Unit**, covering Short, Medium and Long Wavebands.

Each Tuner is for A.C. Mains operation. Circuit Diagrams and Practical Component Layouts are shown, together with complete component Price Lists.

THE WIRELESS WORLD MIDGET A.C. MAINS 2-VALVE RECEIVER

We can supply all the components to build this set, including Valves and Moving Coil Speaker for £3/10/-, including Designer's complete building instructions (these are available separately for 9d.)

THE "SUMMER ALLDRY" BATTERY PORTABLE

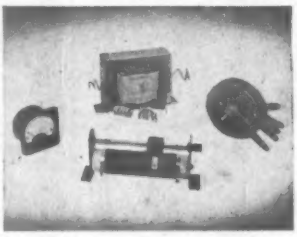
As published in June issue of "Practical Wireless." We can supply, from stock, all the components to build this Midget 3-valve Portable for £2/19/6 (less valves). This also includes dials, top panel and aly. sheet for chassis. The complete article and circuit, including Practical Layout and Price List, is available for 9d.

A complete Kit of Parts to build the Valve Voltmeter specified in the "Electronic Engineering."
This Meter has five voltage ranges, 1-5-25-100 and 250 volts.
For use on A.C./D.C. mains. Price (less case), £3/19/6.
A reprint of complete Assembly Instructions available for 9d.

THE WIRELESS WORLD 3-VALVE SET

A Midget 3-valve T.R.F. Receiver for operation on A.C. mains, covering long and medium wavebands.
We are able to supply all of the components to build this set, as designed, and specified in the Feb. 1950 issue, including the drilled chassis, valves, and moving coil speaker, etc., at the following prices:—
To construct complete chassis, less dial and drive assembly, £4/17/9. Ditto, including dial and drive assembly, £5/19/9.
To construct the complete set, including dial and drive assembly and cabinet, £6/14/3.
Overall size of cabinet is 7½in. × 5½in. × 11½in.
A reprint of the designers article, giving Circuit and Assembly Instructions (this is available separately for 9d.), together with a Practical Component Layout is included with each of above assemblies.

BATTERY CHARGER KITS



All Kits incorporate Metal Rectifiers, and are for use on A.C. mains 220-250 volts. All Kits include an easily followed Wiring Diagram.
For charging 6 v. battery at 1½ amps., £1/2/6.
For charging 6 volt. battery at 1½ amps., with Variable Resistor and Meter, £2/2/6.
For charging 12-volt battery at 1½ amps., £1/6/-.
For charging 12 volt battery at 1½ amps., with Variable Resistor and Meter, £2/5/3.
For charging 6 or 12 volt battery at 3 amps., £1/18/-.
For charging 6 or 12 volt battery at 3 amps., with Variable Resistor and Meter £2/19/-.

The Decca 3-speed Gram. Motor, complete with turntable and "turnover head" type lightweight pick-up, £11/2/6; or less pick-up, £7/3/6.
PICK-UPS:
Cosmocord "G.P.20," for standard records, £3/11/6; interchangeable (G.P.19) Head for L.P. records, £2/3/4.
Decca lightweight "turnover Head" type, for L.P. and standard records, £3/19/2.
Marconi, Standard, lightweight Magnetic, £1/15/10.
Marconi Matching Transformer, 7/6.
Goldring, Standard, lightweight, Magnetic, £1/12/6.

★ *Send 6d. P.O. for our STOCK LIST, it shows "hundreds" of Wireless*

When ordering please include

STERN RADIO LTD., 109

Tel: CENtral

AN A.C. MAINS "ALL-WAVE SUPERHET" CHASSIS

A completely assembled chassis for A.C. mains 200-250 volts, designed for good selective and quality reproduction, and serves as an ideal replacement chassis for that "old radiogram, etc."

It incorporates in addition to the three controls shown above, a Tone Control and a Radio-Gram switch. These two are left on "floating leads" to enable them to be placed in any position on cabinet.

The set employs a modern 5-valve line up, and covers three wavebands, 16-50, 190-550 and 800-2,000 metres. Flywheel tuning is incorporated.

Overall size of assembled chassis, 13½in. × 6in. × 8½in. high. Dial size 9in. × 4½in; an attractive Dial Escutcheon Plate is supplied.

Price of complete chassis, wired and ready for use **£14/19/6**.

A QUALITY "PUSH PULL" AMPLIFIER KIT

A Kit of Parts to build a 6-8-watt Push-Pull Amplifier for operation on A.C. mains 200-250 volts.

Incorporates a simple arrangement to enable either a magnetic, crystal, or light-weight pick-up to be used. A 10-watt Output Transformer is designed to match from 2 to 15 ohm speakers. Tone control is incorporated.

The overall size of the assembled chassis is: 10in. × 8in. × 7½in. high. Price of kit, complete in every detail, including drilled chassis and valves, **£6/5/-**. Component layout is supplied.

Price of assembled chassis, supplied ready for use, **£7/10/-**.

"PERSONAL SET" BATTERY ELIMINATOR

A complete kit of parts to build a Midget "All-dry" Battery Eliminator, giving approx. 60 volts and 1.4 volts.

This Eliminator is for use on A.C. mains and is suitable for any 4-valve Superhet Receiver requiring H.T. and L.T. voltages as above, or approx. to 60 volts.

The kit is quite easily and quickly assembled and is housed in a light aluminium case, size 4½in. × 12in. × 3½in. Price of complete kit, with easy to follow assembly instructions **42/6**.

In addition we can offer a similar COMPLETE KIT to provide approx. 90 Volts and 1.4 Volts. Size of assembled Unit 7in. × 2½in. × 1½in. Price **47/6**.

You're SURE to get it at

STERN'S

ESTABLISHED 25 YEARS

A NEW AND ULTRA MIDGET SUPERHET COIL TURRET FOR 4 PRE-SET STATIONS

Designed on the Rotary Turret principle from which any three stations on medium waveband plus one on long waveband can be received by a turn of the Turret Switch.

The outstanding advantages this unit has over other similar units can be readily seen, the main points being—

(a) Neat and compact, the overall size being only 2½in. dia. × 1¼in. deep.

(b) Easily accommodated, having one hole fixing and requiring only four connections.

(c) The Rotary Turret design switches the actual coils on to positive contacts, thereby reducing stray capacities to the absolute minimum.

(d) For use with Superhet circuits employing 465 K/c. I.F. Transformers.

Selected stations are "set" by means of variable dust cored coils, which give excellent sensitivity and selectivity with use of small trailer aerial.

Price **39/6**

A complete receiver circuit is supplied with each unit.

THE FAMOUS W.B. "STENTORIAN" RANGE OF P.M. SPEAKERS.

Size.	Impedance.	Watts.	Price.
2½in.	2-3 ohms	1	18/6
3½in.	"	2	19/6
5in.	"	2½	21/-
6in.	"	3	24/6
7in.	"	3½	23/6
8in.	"	5	32/3
9in.	"	7	36/9
10in.	"	10	44/6
12in.	15	15	£9

New Mins. Sunplus Speakers. All 2-3 ohms: 2½in. 15/-, 3½in. 14/6, 5in. 14/6, 6½in. 15/6, 8in. 16/9, 10in. 19/6, 12in. 47/6. New Type Rola, 8in. 21/-, 4in. 22/6.

Output Transf. Midget 60-1 (or 90-1) 1in. × 1in. × 1¼in. 3/9. 5-watt Multi-ratio, 12 tappings between 24-1 and 114-1 (some C.T.). 8/6. Wharfedale, 12 watt, push-pull, multi-ratio, 23/6. P/pull, 20 watt, multi-ratio, 37/6, and many others.

Ext. Speaker Volume Control, 2/6.

New Electrolytic Condensers. Not Ex-Govt. All 450/500 volts, 8 mfd. (1¾in. × ¾in. dia.) 2/-, 8-8 mfd. (1¾in. × 1in.) 4/9, 16-8 mfd. (1¾in. × 1in. dia.), 16-16 mfd. (1¾in. × 1¼in. dia.), 32 mfd. (1¾in. × 1¼in. dia.), 5/9. Cardboard Tubular, 4 mfd. 500 v. 3/6, 8 mfd. 500 v. 4/-, 16 mfd. 500 v. 5/9. Can. Standard size, all 500 volt, 4 mfd. 3/6, 8 mfd. 4/2, 8-8 mfd. 5/9, 16 mfd. 5/6, 16-16 mfd. 7/9, 32 mfd. 6/9.

Denco I.F. Liner, for accurately lining 465 K/c. and 1.6 m/c I.F. channels, and associate circuits. Battery operated small and completely self-contained. 47/6.

Potentiometers. New, not Ex-Govt. 2K, 5K, 10K, 25K, 50K, 100K, 250K, ½, 1 and 2 meg. Price, less switch, 3/9. Price with S/Pole switch, 5/9. Price with D/Pole switch, 6/6.

Sarpius Potentiometers. All standard with extended spindles, 5K, 10K, 15K, 20K, 25K, 50K, 100K, ½, 1 and 1 meg., 2/- each.

Ex-Govt. complete set of Moving Coil Headphones and Microphone, with headgear, 10/6.

Coils. Denco "Maxi Q" midget size, L/c wound on Polystyrene Formers, with adjustable iron cores. Available for Aerial, H.F. and Oscillator 465 K/c. or 1.6 M/c. 3/9, each, or with reaction winding 4/9. Denco Matched pair T.R.F. Coils for long and medium waves, 6/6 pr. Weymouth matched pairs of coils, for T.R.F. covering long and medium waves, 10/6 pr., or for Superhet covering Long, Medium and Short waves, 11/6 pr. All types of Wearite "P" coils in stock at 3/- ea.

Coil Packs. Osmor Midget Coil Pack. Size 3½in. × 2½in. × 1½in. covering S. M. and L. waves. Coils wound on Polystyrene Formers with adjustable iron cores, ensures efficient performance. Factory wired and aligned. Price including full circuits for Superhet 465 K/c. Unit 58/- (incl. P.T.). This Osmor Coil Pack is also available for Midget Superhet BATTERY Portable sets including a matched ready wound Frame Aerial. Price 54/2 (incl. P.T.). **Weymouth** Midget 3½ × 2½ × 1½in. covering S.M.L. wibands, for 465 K/c., employing Matched iron Cored Coils on each wband. 51/6.

Wearite Pack, 4½ × 3½ × 1½in. Type 705 covers two short wibands and medium wiband and Type 703 covers short-medium-long waves. Both for 465 k/c. Incorporates gram. position, and employs adjustable cored coils, 53/4.

All of the above Coil Packs include Switching, Padding and Trimmer Condensers.

L.F. Chokes. Midget 10 henry 250 ohms 40 mA., 3/6; 20 hy. 250 ohm 60 mA., 6/6; 20 hy. 300 ohm, 100 mA., 12/9; 5 hy. 50 ohm 250 mA., 28/6; 30 hy. 350 ohm, 120 mA., 15/-; 9 hy. 250 ohm, 120 mA., 8/6, 18 hy., 300 ohm, 200 mA., 25/6.

I.F. Transformer, 465 K/c. New well-known manufacturer's surplus 4in. × 1¼in. × 1¼in. Iron Core, 8/- each. Denco Iron Core, 465 K/c. or 1.6 m/c., 1¼in. × 1¼in. × 3¼in., 16/6 pair. Wearite Stand Cap. Tuned, 465 K/c., 20/- pr. New Surplus 465 K/c. Iron Core, 4in. × 1¼in. sq., 10/- pair.

Transformers. (a) Input 230 volt, output 300 volts 25 m.a., and 6.3 v. .9 amp., 11/-; (b) Input 230 volts, output 250 volts 30 m/a. and 6.3 volts 1 amp., 13/9.

E.H.T. Transformer. Prim. 230 v. Sec. 5 Kv. and 4 volt, tapped 2 volt, 59/6. Do., but 4 Kv., 54/-.

Heater Ratio Transformers. (a) tapped 2 v. 4 a., 5 v., and 6.3 volts 3 amp., 9/6; (b) 4 v. 2 amp. to 5 v. 2 amp. Reversible, 6/6; (c) 4 v. 3 amp. to 6.3 v. 2 amp. Reversible, 6/6.

NEW SURPLUS !! FOSTER TRANSFORMERS. Primary 230 volts. Secondary 1K volts 9 amps. 21/-.

Filament Transformer. Inputs 230 volts, outputs 6.3 v. 1½ amp., 8/3; 4 v. 1½ amp., 7/6; Input 200/250 v., output 4 v. (C.T.), 1½ amp., 4 v. 2 amp., 6.3 v. 2 amp., 12/6. Input 220 v. output 6.3 v. (C.T.) 4 amps., 17/6.

Metal Chassis, substantially made with four sides, 7in. × 4in. × 2in. 3/11, 9 × 8 × 2½ 5/3, 10 × 6 × 2½ 5/-, 10 × 7 × 2½ 6/3, 12 × 9 × 2½ 7/9, 14 × 9 × 2½ 8/3, 16 × 8 × 2½ 9/-.

Mains Transformers. All New Stock with Primaries tapped for 200-250 volts. Secondaries (a) 250-0-250 volt, 80 m.a., 6.3 v. (tapped 4 v.) 4 amp. and 5 v. (tapped 4 v.) 2 amp., 18/6 (also available with 350-0-350 volt at 18/6). Stern's 350-0-350 volt, 150 m.a., 6.3 v. (tapped 4 v.), 4 amp. and 5 v. (tapped 4 v.) 2 amp., 41/6; (c) 350-0-350 v., 250 m.a., 4 volt, 6 amp., 4 v. 3 amp. 6.3 v. (tapped 3 v.) 2 amp. and 6.3 v. 6 amp. 79/6, and many other ratings.

Westinghouse Rectifiers, (a) H.T. 51. Rated 350-0-350 volts, 100 m.a., 35/-; (b) H.T.52. Rated 350-0-350 v., 200 m.a., 37/6; (c) H.T.53. Rated 500-0-500 v., 200 m.a., 50/-; (d) Type 16H.T.56, 17/9; (e) Type 36E.H.T.25, 11/9; (f) Type 36E.H.T.25. Rated 2.5 kV., 1 m.a., 17/6; (g) Type 36E.H.T.160. Pulse rating 5/6 kV., 28/6.

F/Wave Bridge Rectifiers.

For charging 2, 4 or 6 volt at 1½ amps.	8/6
For charging 6 or 12 volt at 1½ amps.	11/9
For charging 6 or 12 volts at 3 amps.	19/9
For charging 6 or 12 volts at 5 amps.	25/-
For charging 12 or 24 volts at 3 amps.	34/6

A Variable Resistor for control of Charging Equipment (or Models) up to 3 amps., 13/6; or up to 6 amps., 17/9.

Suitable Charger Motor, max. 4 amps., 7/6.

Meter Rectifiers. Westinghouse 230 micro/amp., 11/6; 1 m.a., 10/6; 2 m.a., 6/6.

Selenium Rectifiers. H.T./H. wave. 250 v. 50 m.a., 5/6; 250 v. 100 m.a., 7/6; 250 v. 170 m.a., 13/9.

Charger Transformers. Suitable for use with preceding Rectifiers. Each has input of 230 volts. Outputs (a) 24 volts tapped 15 v. 9 v. and 4 v. at 3 amps., 23/9; (b) 30 volts tapped 15 v. and 9 v. at 3 amps., 25/9; (c) 15 volts tapped 9 v. at 3 amps., 17/9; (d) 12 volts 1½ amps., 11/9; (e) 15 volts tapped 9 v. at 6 amps., 23/-; 15 volts tapped 9 v. at 1½ amps., 14/3; 12 volts 1 amp., 7/6.

A Battery Charger Wiring Diagram is included with purchase of Charger Transformer and Rectifier.

Adjustable Mains Droppers. 1½in. dia. × 9in. ea. 1b amp., 1,500 ohms., 5/-; (b) .2 amp., 1,000 ohms, 4/3; (c) .. amp. 600 ohms, 5/-.

Television. We keep a very comprehensive range of T/V. components. The Viewmaster T/V. Assembly Instructions showing Practical Layout and Price List is in stock, price 5/6 (incl. post). We can supply all the specified components for the T/V. ex stock, either by way of individual components or by the published stages.

"Q" Max Chassis Cutters. The quickest and most simple method of chassis cutting, consists of a die, punch, and Allom screw.

To cut ¾in. dia. (B7G)	10/6
To cut ¾in. dia. (B8a)	10/6
To cut 1⅛in. dia. (Octal)	13/6
To cut 1⅛in. dia. (English)	13/6
To cut 1¼in. dia. (EF50)	14/6
Key for any of above	1/-

Adjustable **Chassis Cutter** for holes from ¼in. to 2¼in. dia. (used with hand brace), 7/6.

The "Handy-Utility" ¼in. Portable Electric Drill for use on A.C. or D.C. mains. A powerful and robust drill that will drill wood, metal, and almost anything, can also be used for grinding, buffing and wire brushing, etc. Employs instant release trigger switch. Price £6/10/-. Descriptive leaflet is available.

The new **Pyrobit Soldering Iron,** with instrument type bit, for use on A.C. or D.C. mains, 22/-. Spare elements and bits always in stock.

Components and many KITS OF PARTS for both Sets and Battery Chargers. approx. cost of Post & Packing.

& 115 FLEET STREET., E.C.4

5814 and 2280

LASKY'S RADIO
World Renowned for Service & Reliability

TELEVISION CONVERSIONS

LARGE BLACK AND WHITE PICTURES

WESTINGHOUSE BOOST E.H.T. KIT
Comprises one 36EHT40 rec., one 2-meg. resistance and two T.C.C.-.001 mfd. 6 Kv. condensers. For converting 9in. T.V. receivers to 12in.
LASKY'S PRICE 30/- Postage 1/- extra.

PLESSEY TELEVISION

Line E.H.T. Trans.	24/6
Focus Ring	22/6
Line width coil	10/-
Boost choke	5/9

METAL RECTIFIERS
800 volts at 5 m/a. and 1,200 volts on pulse circuits.
LASKY'S PRICE 9/6 Postage 9d. extra.

TYPE 36EHT100 By Westinghouse.
7 Kv. **PRICE 26/8.** Postage 9d. extra.
TYPE 36EHT25 1.8 Kv. **PRICE 13/10.**
36EHT35 2.5 Kv. **PRICE 18/2.**
36EHT40 2.9 Kv. **PRICE 20/6.**
36EHT45 3.4 Kv. **PRICE 22/6.**
36EHT50 3.6 Kv. **PRICE 24/10.**

EY51 High voltage rectifier. **EL38** T.V. line oscillator.
PRICE 24/4 each.
Postage 6d. each extra.

10 in. CONVERSION KIT
Comprises 10in. Cossor cathode ray tube type 108K, line fly-back E.H.T. transformer, EY51-EHT rectifier, scanning coils, 10in. cream mask and armour plate glass.
YOURS FOR £15.10.0
Carriage and insurance 25/- extra.

12 in. CONVERSION KIT
Comprises 12in. cathode ray tube (by either Brimar, Mullard or Mazda), Westinghouse Boost EHT Kit, 12in. mask and armour plate glass. Inductance width control.
YOURS FOR £20.18.4
Carriage and insurance 25/- extra.

SPARES FOR OUR £25 T.V. RECEIVERS
All now available from stock. Prices on request.

TELEVISION POT/METERS
200 ohm, 400 ohm, 500 ohm. Wire wound.
LASKY'S PRICE 1/6 each.
Postage 3d. extra.
Wire slider type (on ceramic tube). 2,000 ohm, 1,000 ohm.
LASKY'S PRICE 1/6 each.
Postage 3d. extra.
All other values available from stock. Wire wound and carbon, long and short spindle.

CATHODE RAY TUBES
All types and sizes available from stock. Brand new and fully guaranteed.

12in.	from	£18	4 10
15in.	from	£22	16 10
16in.	from	£24	6 5

FRAME BLOCKING OSCILLATOR TRANSFORMERS
LASKY'S PRICE 4/6 each.
Post 4d. extra.

T.V. SCAN COILS FOR LINE AND FRAME. Brand new, manufacturer's surplus. For 9in. or 12in. C.R. tubes.
LASKY'S PRICE 14/6
Post 1/-.

P.M. TELEVISION FOCUS MAGNETS
Suitable for any type of cathode ray tube. Tetrode and Triode.
LASKY'S PRICE 16/11 each.
Postage 1/- extra.

LINE E.H.T. TRANSFORMERS
Famous manufacturer's surplus. 6 Kv. output with heater winding for EY51.
LASKY'S PRICE 9/6 each.

HIGH VOLTAGE CONDENSERS
.1 mfd. 4 Kv. Price 3/11 each.
.1 × .1 mfd., 3.5 Kv. Price 7/11 each.
T.C.C. VISCONOL TYPE (Cathodray)
.001 mfd. 6 Kv. Price 4/6 each.
.001 mfd. 12 Kv. Price 7/6 each.
.1 mfd. 7 Kv. Price 18/- each.
All post extra.

CO-AXIAL CABLE
Standard impedance.
Single screened, 1/- per yard.
Twin screened, 1/6 per yard.
Twin balanced feeder, 7½d. per yard.
Post extra. Any length cut to your requirements.

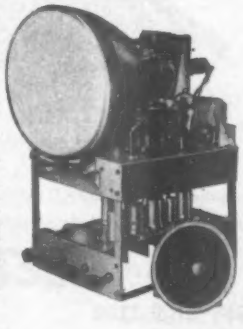
TELEVISION CONSOLE CABINETS

DE LUXE MODEL

Beautiful Walnut Veneer

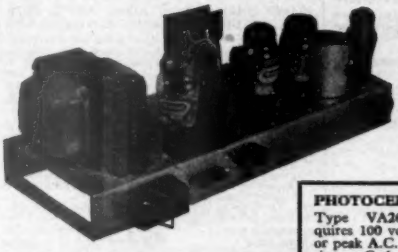
For 9, 10 or 12in. cathode ray tubes. Beautiful figured medium walnut finish, with high polish. Fitted with shelf for receiver, glass, speaker baffle and fret, and castors for easy movement. Undrilled. Suitable for use with the Viewmaster.
"Electronic Engineering," "Practical Television," "Practical Wireless," and "Wireless World" televisors
LASKY'S PRICE
£8.10.0
Carriage 12/6 extra.
Outside dimensions of cabinet: 17½in. × 16½in. × 32in. high.
Why not convert your table receiver to a console?

THE VIEWMASTER



The television set you can build at home from standard parts.
Alexandra Palace, Sutton Coldfield and Holme Moss operation.
Brilliant high definition black and white picture.
Superb reproduction.
Uses 9in. or 12in. Cathode Ray Tube.
Table or Console Model.
Incorporates all the latest developments.
Television for the home constructor at its finest.
Send to-day for the CONSTRUCTION ENVELOPE, a 32-page booklet crammed with top-rate information and all the necessary data, also 8 full-size working drawings and stage by stage wiring instructions.
Model "A" for use in London and Home Counties.
Model "B" for use in Sutton Coldfield Area. Model C for Holme Moss.
PRICE 5/- per copy.
Post free.

"AMPLIFIERS" AT THE LOWEST EVER PRICES



LASKY'S RADIO — World Renowned for Service & Reliability

J/RA/2. 10-12 WATT CHASSIS AMPLIFIER. Uses an L63 feeding 2 KT61s in push-pull. Rectifier type U 50. Size: 6in × 17in. on 2in. chassis.

LASKY'S PRICE £7.19.6 Carriage and packing 10/- extra.

SAFETY FIRST. Fused test prods. Fully insulated pencil type with retractable point. Contact is only made when desired by pressing top. Each prod contains a cartridge type fuse and spring.
LASKY'S PRICE 4/11 per pair (one red, one black). Post 6d. extra.

EX A.M. RADAR INDICATOR UNIT TYPE 62. Unused but soiled. Containing 20 valves and a 6in. C.R. tube type VCR97. Valve line-up :—16 SP61 ; 2 EA50 ; 2 EB34. Dozens of components, resistances, coils, condensers, 117 Mc/s crystal, pot. meters, etc. Totally enclosed in metal case. Size : 18in. × 9in. × 11in. Weight 40 lb. Enamelled grey or black with coloured control knobs.
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Carriage 10/- extra.

TYPE 6 INDICATOR UNITS. BRAND NEW AND UNUSED. In makers' original cartons. Contains a 6in. c.r. tube type VCR97 and 7 valves :—4 EF50, 3 EB34. Also 12 pot/meters, and hundreds of assorted components, resistances, etc. In metal case, grey enamelled, size :—18in. × 8½in. × 7½in.
LASKY'S PRICE 79/6
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CATHODE RAY TUBES MASKS.
9" 7/6 ; 9" fitted with armour plate glass 10/6.
10" 9/6.
12" Black 10/6. Soiled white 10/-. Brand new white 19/6. White, with fitted armour plate glass, 21/-. Special for flat face tubes, 22/-.
15" Soiled white, 12/6. New, perfect, 27/6.
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TABLE MICROPHONE STAND. Two sections, chrome plated. Crackle finished base. **LASKY'S PRICE 21/-** Post, packing 2/6 extra.

PHOTOCELLS.
Type VA26. Requires 100 volts D.C. or peak A.C. to function. Cathode area 15 sq. cms.
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Post 1/6 extra.

LONG AND MEDIUM T.R.F. COILS. With reaction.
LASKY'S PRICE 6/9
Per pair. Post 6d. extra.
Less Reaction.
LASKY'S PRICE 5/11
Post 6d. extra.

SELENIUM METAL RECTIFIERS.
12 volts 6 amps., 27/6, post 9d. extra.
12 volts 1 amp., 7/9, post 9d. extra.
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350 volts 80 m/a., 7/11, post 6d. extra.
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FILAMENT TRANSFORMERS. Primary 230 volts 50 c.p.s.
FIL/2, 6.3 v. 1.5 a. ... ... Price 7/6
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FIL/4, 2 v. 2 a. ... ... Price 5/-
Special Transformer. 30 volts at 2 amps., with the following tappings :—3, 4, 5, 6, 8, 9, 10, 12, 15, 16, 20, 24 and 30 volts ... Price 19/6
All fil. trans. 1/- extra per item postage.

MAINS TRANSFORMERS. All 200-250 volts 50 c.p.s. primary. Finest quality, fully guaranteed.
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MBA/5. 350-0-350 v. 125 m/a., 6.3 v. 4 a., 5 v. 3 a. With mains tapping-board. Price 32/6
MBA/8. 350-0-350 v. 100 m/a., 6.3 v 3 a., 5 v. 2 a. With mains tapping board. Price 22/6
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COIL PACKS. ALL AT PRE-BUDGET PRICES.
By Weymouth. No. 1. Standard long, medium and short wave coverage. Simple single hole fixing. For use with 465 Kc/s I.F.'s. Size :—3¼in. × 2¼in. × 4½in. Price 35/-. Postage 1/6 extra. **No. 2.** As above, but of miniature dimensions, as follows :—3¼in. × 1¾in. × 2¼in. Price 44/-. Postage 1/6 extra.
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ALL OTHER TYPES AVAILABLE.

ANTENNA ROD SECTIONS. Each section is steel heavily copper plated, 12in. long and ¼in. in diameter. Any number of sections can be fitted together. **LASKY'S PRICE 2/6** per doz. ; **6/-** for 3 doz. ; 11/- per half gross ; **20/-** per gross. Post free.

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LASKY'S PRICE 39/6 Postage and packing 3/6.

MATCHING TRANSFORMERS. Type T268A. Price now reduced to 12/6 each.

TYPE J/RA/1. 30 watts. HEAVY DUTY AMPLIFIER. Rack mounting, grey crackle finished. Uses KTZ63 and L63, feeding 2 KT66s in push-pull. Rectifier type U52. Meter and switch for checking all current readings. Panel light, bass brilliance and gain controls. Size : 19in. × 12in. × 12in. on a chassis 4½in. high.
LASKY'S PRICE £13.19.6
Carriage and Packing 25/- extra.

MAINS SMOOTHING CHOKES. All 10-20 Henrys.
40 m/a. ... **3/6** 80 m/a. ... 4/11
100 m/a. ... **6/11** 120 m/a. ... 7/6
150 m/a. ... **10/6** 250 m/a. ... 15/6
Special Choke Type SCR1. 2,000 ohms, 150 H. at 75 m/a. ... ... Price 8/6
Postage 6d. per choke extra.

VIBRATOR PACKS. For use with the P.C.R. Philips Communications Receiver. 12 volt input. Supplied complete with vibrator and metal rectifiers, etc.
LASKY'S PRICE 39/6
Carriage 5/- extra.

SOLON SOLDERING IRONS. For 230 volts. All 65 watts. Price : Straight bit, 19/- ; Pencil bit, 21/-. Postage 1/6 per iron extra.

RESISTANCES. ALL VALUES, ALL SIZES. 5 ohms to 50 meg. ohms. Send us your order. Prices : ½ and 1/10 watt, 7½d. each ; ¼ and ½ watt, 4d. each ; 1 watt, 3d. each.

CO-AXIAL CABLE. Suitable for television. 80 ohm. Single, 1/- per yard ; twin 1/3 per yard. Twin feeder at 7½d. per yard.

CONDENSERS. ALL BRAND NEW.
8 mfd. 500 v.w., 3/6. 8 mfd. 450 v.w., 3/-.
16 mfd. 500 v.w., 4/6. 16 × 16 mfd. 450 v.w., 5/6.
25 mfd. 25 v.w., 1/11.
8 × 16 mfd. 500 v.w., 6/6.
60 × 100 mfd. 350v.w., 8/6.
64 mfd. 500 v.w., 6/6. 8 × 8 mfd. 500 v.w., 4/11.
Postage extra.

LASKY'S RADIO

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Bargains in Ex-Service Radio and Electronic Equipment

JEFFERSON-TRAVIS UF-2 TRANSCEIVER CHASSIS

Partlystripped by the M.o.S., less valves, tuning inductances etc, connections, but otherwise fairly intact. A fine basis for a transportable type two way radio. Original frequencies 60-75 mcs. Valve types 2/6Y7, 12J5. The unit comprises two chassis, with controls and speaker mounted on chrome plated etched steel panels, housed in cabinet finished black crackle, dim. 15½ × 10½ × 8½in.

CLYDESDALE'S PRICE ONLY **£2 . 10 . 0** CARRIAGE PAID

Circuit of UF-2 available at 1/9.

JEFFERSON TRAVIS UF-1 POWER SUPPLY

Complete self contained vibrapack, Input 12 volts. Outputs 150/180 v. D.C. 30/50 ma. Choke capacity smoothed and 2 L.T. taps. Unused but vibrator contacts stuck due to long storage. Complete with synchronous vibrator, smoothing cond. etc., in metal case dim. :—7 × 3 × 4in.

CLYDESDALE'S PRICE ONLY **19/6** CARRIAGE PAID

S-440-B V.H.F. TRANSMITTER CHASSIS

Partly stripped by the M.o.S. less valves, tuning coils and crystal but otherwise fairly intact.
A fine basis for VHF Tx. or 144 mcs. rig.
Original frequencies 85-98 mcs. valve types 3/RK34, 2/6N7 6V6.
Housed in louvred case finished grey crackle. Dim. 14 × 8 × 7in.

CLYDESDALE'S PRICE ONLY **27/6** POST PAID

Circuit of S-440-B available at 1/3.

FOR EXPORT ONLY. WIRELESS SET No. 38 Mk. 2. BRAND NEW

A haversack type Transceiver range up to 5 miles. Frequencies 6-9 mcs. 5 valves: 4AMP12, ATP4, complete with Headphones, Throat Microphones, Aerials, Junction Box, Spares, Satchels and Instruction card.
4 complete units packed in wood case 57½ × 14 × 14in.

PRICE ON APPLICATION.

COMMAND TRANSMITTER CHASSIS

Partly stripped by the M.o.S., less valves, coil winding, crystal and dynamotor, but otherwise fairly intact.
A fine basis for ideas in V.F.O. or Tx.
Models BC-457 to BC-459 componentsie identical, valve types 2/1625, 1626, 1629.
Conversion suggestions and circuits supplied.
In aluminium case dim. :—7½ × 5 × 8½in. Wgt. 8½ lbs.

CLYDESDALE'S PRICE ONLY **15/-** POST PAID

Conversion suggestions and circuits available at 2/6.

SPEECH MODULATOR BC-456

Command Modulator unit with valves, 1625, 1935, VR150/30 less dynamotor, otherwise complete in metal case 10½ × 7½ × 4½in., chassis depth 2½in.

CLYDESDALE'S PRICE ONLY **19/6** CARRIAGE PAID

Circuit for the BC-456 available at 1/3.

TEST EQUIPMENT IE-45-A

Command series Test Gear with 3 Antennas, 3 Test Units, Mod. BC-456-B (or E) with dynamotor, Antenna Relay, 3 Radio Control Boxes, 2 Racks, 6 Mountings, IF Shunt Unit, Control Unit MC-227, and 17 Cable Assembly.

CLYDESDALE'S PRICE ONLY **£22 . 10 . 0** CARRIAGE PAID

MICROPHONE T-17B

Made by Shure Bros. of Chicago, U.S.A.

Carbon handset mic. with press-to-talk switch, stowing hook, cord and jack plug as used with Command series, etc.

CLYDESDALE'S PRICE ONLY **30/-** POST PAID

220V. D.C. CHARGING BOARD

H.543. These charging boards a.e designed for charging 1-60 cells at 3 amps. Constructed by Bepco of Canada and mounted on a metal chassis with case 21½ × 13½ × 4½in. which is well ventilated and has 4 lugs for fixing to a vertical service. There is mounted on the metal panel 100 ohms charging resistance, 5 amp. meter, 220 Volt Auto cut-out with transparent cover, fuses, 2 Flush mounting switches.

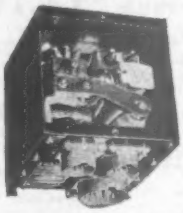
CLYDESDALE'S PRICE ONLY **£2 . 5 . 0** POST PAID

12 VOLT MOBILE AMPLIFIER UNIT

Made by Parmeko, uses EF36, EC31 and 2 EL35 in Class AB1 push pull. Dynamotor powered, controls, combined Mic/Gram gain, separate H.T. and L.T. switches, built in metal case finished grey. Dim. 12 × 9½ × 10½in.

CLYDESDALE'S PRICE ONLY **£9 . 9 . 0** CARRIAGE PAID

AMPLIFIER A1271 IOU/549



A one valve (VR56 = EC36) Amplifier Chassis, with 400 ohm, 4M 2B relay, 2 transformers, vol. control, cond., and resistors, mounted on rubber in a black finished metal case, 5 × 5 × 4½in. All conn. brought to 4, 6 and 12 p. plugs.

CLYDESDALE'S PRICE ONLY **10/6** POST PAID

FLUXMETER WY.8023

Designed to calibrate the field of Magnets within the range of 500 to 4,000 gauss and to determine their polarity. Complete with probe unit and contained in a hardwood case with hinged lid and handle. Instructions on lid.
Dim. : 12½ × 9 × 6in.

CLYDESDALE'S PRICE ONLY **£5** CARRIAGE PAID

DINGHY TELESCOPIC MAST

A lightweight (4 oz.) mast for many uses, Car Aerial, Camera, Tripod, Fishing Rod, etc. Made of aluminium, 7 sections Closed 14½in. Extended 7ft. 6in. Diam. base ½in., top 7/16in.

CLYDESDALE'S PRICE ONLY **6/-** POST PAID

AERIAL INSULATORS LOA/1275

Black plastic chain insulators, 3 links, each 3½in. long, 1½in. wide. Total length 7½in.

CLYDESDALE'S PRICE ONLY **1/6** per pair POST PAID

HAND GENERATOR 10 watt Mk. II

Designed for WS.48 and WS.18, driven by two handles, complete with operators seat. Speed should be 50/70 r.p.m. smoothed outputs 162 v, 60 ma., 2.1 v, 2 a. and 12 v. Generator Dim. :—5½ × 5½ × 6½in. wgt. 13 lbs.
Leg w/seat dim. :—33 × 6 × 2½in. wgt. 5½ lbs.
Legs (2) dim. :—26 × ½in.

CLYDESDALE'S PRICE ONLY **45/-** CARRIAGE PAID

CRYSTAL OVEN

Brand new, extremely sensitive with adjustable thermostatic control and thermometer. Built into a cork lined metal box 12 × 6½ × 6½in. Wgt. 7¼ lbs.

CLYDESDALE'S PRICE ONLY **£3 . 19 . 6** POST PAID

PUMP DESSICATOR ADM. PATT. 12128 FOR TELESCOPES AND BINOCULARS

Hand operated complete with spare gel cell and cond. tubes. Stroke cap 400 cm. fitted humidity gauge, reads 10-100% vacuum gauge 0/30in. In wood transit case 19½in. × 12in. × 9in.

CLYDESDALE'S PRICE ONLY **£5 . 10 . 0** CARRIAGE PAID

COOLANT PUMP. By Packard U.S.A

A turbine type pump, directly driven from semi-ball point splined socket (by motor not supplied) clockwise rotation, with safety valve, sludge vent, etc.
Dia. of turbine 6in. dia. of pump chamber, 6½in., depth 2in. Inlet and outlet dia. 1¼in. Overall dim. : 11½ × 7½ × 13in.

CLYDESDALE'S 1 RICE ONLY **49/6** CARRIAGE PAID

FEATHERING PUMP SU/402

Driven by 24 v. D.C. motor type C2801, through 2.1 reduction gear, fluid moved by two 12 tooth wheels. Safety valve fitted. Overall dimensions 12½ × 6 × 6in. Pumping rate : lubricating oil 2 gals. per min. approx. Air pressure : 40lb. per sq. in. Oil pressure : over 100 lbs. per sq. in. Inlet ¼in Outlet ¾in.

CLYDESDALE'S PRICE ONLY **£2 . 10 . 0** CARRIAGE PAID

ELECTRONIC IGNITION TESTER Type V.E.D. Patt. 543562, made by English Electric.

A Cathode Ray Tester employing an entirely new technique in ignition testing of internal combustion engines. Enables the electrical performances of the entire ignition system to be observed on the screen of the Cathode Ray tube, while the engine is running. Will operate from 6, 12 and 24 volts D.C. or 230 v. A.C. Built into a black crackle case, with hinged front and carrying handle, dim. : 15½ × 6½ × 11½in.

CLYDESDALE'S PRICE ONLY **£35** CARRIAGE PAID

MORSE KEY U.S.A. PATT. TYPE C.J.B.

Made by J. H. Bunnell & Co. enclosed contact type, as used in American aircraft. Finish black crackle. Complete with contact and tension adjustments and capable of speeds up to 25 w.p.m. Dim. 5½ × 1½ × 2in.

CLYDESDALE'S PRICE ONLY **12/6** POST PAID

INDICATOR UNIT TYPE 217A

Containing 100 microamp fsd. 2½in. flush mtg. meter, dial calibrated in yards ; vol. controls, toggle sw. etc., in metal case 6 × 4½ × 2in.

CLYDESDALE'S PRICE ONLY **25/-** POST PAID

MULTICORE CABLE

8 core, metal braided and PVC covered, 1/9 per yard.
6 core, metal braided and PVC covered 1/6 per yard.
2 core, metal braided 6d. per yard.
Metal braided sleeving 3 mm. 1 yard long, 3 for 1/-.

RECEIVER R3547

This ex-Air Ministry receiver probably provides one of the greatest breakdown values of any of the Radar receivers. The chassis contains a 45 Mc.s I.F. strip employing 5, EF50 valves, together with a further 10 EF50's, 3, EB34's, 2, EF36's, 2 VR72's, and an EA50. Numerous condensers, potentiometers, resistors and relays. Also a 24 V. reversible motor. The complete unit is built onto a steel chassis and enclosed in a metal cabinet 18 × 13 × 7½in. Finished in black.

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COMMUNICATION RECEIVER R1155. A first rate superhet. communication receiver already well known to most short-wave enthusiasts, home and overseas. As an introduction may we suggest the new revised and enlarged "*Wireless World*" leaflet which gives the circuit data and all relevant information. We can supply this at 1/3 post paid. The receivers are in brand new condition and in perfect working order and very moderately priced at £11/19/6. We believe that this will be the last release of these famous receivers so buy now. Carriage and packing in original transit cases 10/6. Any set gladly demonstrated to callers.

ELECTROLYTIC CONDENSERS. 8 mfd. 600 v. working, 700 v. surge, three for 10/- post paid. 16 mfd. 500 v. working 600 v. surge, three for 11/6 post paid. These condensers are tall can type single hole fixing. Minimum quantity by post is three.

BLOCK CONDENSERS. Electrolytic, 8 mfd. 500 v. working. Three for 9/- post paid.

NEW EXIDE ACCUMULATORS. 2 volt, 15-20 AH, in black bakelite case. Size 6in. x 1¾in. square. Brand new at 4/6 each plus 9d. post.

BATTERY CHARGERS. Contained in a black crackle case size 6in. x 7in. x 12in. includes a heavy duty transformer, metal rectifier, 0-5 ammeter, on/off mains switch and 2 Slydlock fuses. 230 v. 50 cycles input, output 4 amp. 6 or 12 volt battery. The transformer etc. is conservatively rated, and the whole unit is of sturdy construction and super quality. Made to a very stringent specification, this equipment is well worth the price of £4/19/6 plus 5/- carriage and packing. In brand new unused condition.

R3001 RECEIVER. Consists of two chassis hinged together in metal case. One chassis consists of R.F. stage, mixer and oscillator using 3/EF50s followed by I.F. strip of 45 Mc/s employing 5 VR65 (SP61) and an EA50. The other chassis consists of high cycle power pack, 24 v. D.C. motor, numerous condensers, resistors, etc. Circuit for I.F. strip is supplied. Less valves at only 19/6 plus 3/6 carriage.

PORTABLE TESTING INSTRUMENTS. These multimeters are perfect, brand new and contained in manufacturer's original boxes. The instrument is a moving coil volt ohm milliameter, complete in an attractive carrying case with handle. The dial is calibrated for readings of 0-1.5 v., 0-3 v., 0-60 mA. and 0-5000 ohms. Further ranges may be added as desired. A range switch is incorporated and the basic movement is 6 mA. 250 ohms resistance. Our price 15/- plus 1/6 post and packing.

CAR BATTERY. American made by Reading. 6 v. 90 AH. 7¼in. x 8¾in. x 7in. Brand new in original packing. 79/6, plus 5/- carriage.

SIMPSON DUAL RANGE OHMMETERS. Brand new American instruments. Incorporates 2½in. moving coil meter, ranges 0-2000, and 0-200,000 ohms. 52/6 post paid.

'SCOPE BARGAIN

Erskine Lab. Ltd. Oscilloscope Type I/B. Ready for use on 200/250 volt A.C. mains. Time Base Range: 10-350,000 c/s in three ranges, continuously variable. Panel Controls for Brilliance Focus, T.B. Fine, Sync., X input, Y input, X gain, Y gain. Has Y plate amplifier and X plate amplifier available when time base inoperative. Sync. is adjustable, and derived from the Y axis signal. Contains two Mazda 6FI2 valves and G.E.C. type E4103/B/4 C.R.T. Housed in black metal case with carrying handle size 7¾in. x 5½in. x 11in. Weight only 10 lbs. **Brand new and boxed** with circuit, special bargain price, only £10/10/- plus 5/- carriage and packing.

BAKELITE EXTENSION SPEAKER. Cream cabinet size 6¼in. x 6¼in. x 3¼in. Containing 3in. Rola Speaker, 2/3 ohm. Brand new and boxed 22/6 plus 2/6 post and packing.

MANSBRIDGE CONDENSERS. 10 mfd. 1000 v. test. Size 3¼in. x 3in. x 2in. Will work at 600 v. D.C. Price 3 for 10/6 post paid. These are brand new and boxed.

METAL RECTIFIERS. 12 v. 2 A. full wave bridge, 12/6 plus 6d. post. Miniature H.T. rectifiers, type RM2-125 v. 100 mA. 4/3 each, or 2 for 8/-. RM3-125 v. 120 mA. 5/- each or two for 9/6 plus 6d. post for one or two.

MULTIPLE BLOCK CONDENSERS. Electrolytic, 8 x 16 x 4 x 4 x 6 mfd., all for 450 v. working, 4/9 plus 9d. post or two for 10/- post paid.

R1155 POWER PACK AND OUTPUT STAGE. Enables this receiver to be operated direct from A.C. mains, just plug in and connect low impedance speaker. (Note: speaker not supplied.) £3/19/6 carriage paid. This unit is manufactured by ourselves from new components and valves and assembled in a neat black A.M. case, size 8¼in. x 6¼in. x 4in. All the necessary connecting leads and plugs are supplied and included in the price.

MAINS TRANSFORMERS Three types, all standard primaries. Universal mounting. (1) 350-0-350 volts, 80mA. 0-4-6 .3 v. 0-4-5 v. 2 a. (2) 250-0-250 v. 80 mA. 0-4-6.3 v. 4A. 0-4-5 v. 2 A. (3) 30 v. 3A. tapped at 3 v., 5 v., 6 v., 8 v., 9 v., 10 v., 10 v., 12 v., 15 v., 18 v., 20 v., 24 v. All these transformers are brand new and boxed, fully guaranteed and priced at 18/6 each, plus 9d. postage.

45 M/CS. "PYE" STRIP. A ready made vision receiver for London frequency. Uses six EF50 and an EA50. Circuit data provided. Less valves 37/6 with all valves 57/6 plus 1/6 post and packing.

Special Offer on manufacturers surplus transformers—standard tapped primary. 375-0-375 v. 20 mA. 6.3 v. 8 A. 5 v. 3 A. 4 v. 2 A., 4 v. 2 A. Size 4¼in. x 4in. x 3in. Semi-shrouded, drop through type. A bargain offer at 39/6 plus 1/6 post and packing.

WAVEMETER CLASS 'D' No. 1 Mk2, in brand new condition and in original transit boxes, complete with spare valve and spare vibrator. We have again been fortunate in obtaining a very small quantity of these G.P.O. approved instruments. Doubtless this consignment will be the last for release. The Wavemeter is complete with instruction book containing circuit diagram and full technical and operating data. Price: £5/19/6 plus 3/6 carriage/packing. Details of mod. for AC operation available on request.

RECEIVER TYPE 21. A battery operated superhet covering 4.2-7.5 Mc/s and 19-31 Mc/s. Operates as a double superhet on the 10 metre band. Complete with nine 2 v. valves and circuit diagram. In new condition. Only 45/-, carriage paid.

EX-R.A.F. U.H.F. ANTENNA. This consists of an EA50 untuned detector stage mounted on a moulded streamlined base. The copper antenna measures 22.5 cm. All connections are brought out to a 3 pin screened connector. These units are brand new and boxed. Only 2/- post paid.

24 V. EXTRACTOR FAN. For operation from 24 v. AC/DC but will function from mains when fitted with a suitable dropper resistance. Has many uses—ventilation purposes, as a hair dryer, etc. AS NEW. Only 12/6 plus 1/6 post and packing.

FOR THE PERSONAL CALLER

We still hold limited stocks of the following:

R1155 RECEIVERS, TYPE 62 INDICATOR UNITS, TYPE 62A INDICATOR UNITS, MEDIUM-WAVE COMMAND SETS, COMMAND SETS TYPES BC453, 454 AND 455

AND our usual range of valves, C.R. Tubes, 'scopes, valve voltmeters, quality amplifiers and specialised experimental equipment. October month is bargain month. Pay us a visit. 3 minutes from Leicester Square Station (up Cranbourne Street).

MODULATOR UNIT TYPE 168. Contains 1 of 5U4G, 1 of EF50, 3 small neons, 1 Klystron, 1 of CV85 (Triggertron), 2 long metal rectifiers, resistors, condensers, etc. All housed in a handsome metal case. Packed brand new in transit cases, 27/6, plus 7/6 carriage.

E.H.T. TRANSFORMERS for VCR97 or VCR517 tubes. 2,000 v., 4 v. for tube heater and 4 v. tapped 2 v. for E.H.T. rectifier. Brand new and fully guaranteed. Our price 35/-, plus 9d. post.

EF50 (VR91). Red American Sylvanian types at 8/6 each. Brand new.

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GARLAND BROS

LANE PRECISION BUILT TAPE TABLE. High fidelity high impedance record-playback and erase heads in mumetal shields. Heavy balanced flywheel giving freedom from "wow" and "flutter." Fast rewind. Heads are half-track, giving one hour's playing time with 1,200-foot reel of tape. £16/10/-, plus carriage, etc., 10/-.

TAPE DECK AMPLIFIER UE6. A six-valve record-playback amplifier suitable for use with high or low impedance heads. Features include variable bass and treble lift, recording level indicator and built-in oscillator supplying h.f. bias and erase sufficient for the highest coercivity tapes. Supplied in kit form, with punched chassis, all valves, components, circuits and full instructions. £10/10/-, plus carriage 5/-.

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AMPLIFIER AC11. Further deliveries enable us to offer a limited number of kits for this popular amplifier. Specification : 7 valves (including rectifier). 10 watts push-pull output to 3 ohm or 15 ohm speaker. Supply available for tuner unit, etc. High and low gain inputs. Separate Bass and Treble controls. Negative Feedback. Varley mains and output transformers. Complete kit, with circuits and instructions, including circuit of suitable local-station quality tuner, £8/19/6, plus carriage 5/-.

MODIFICATION KIT UE2. Enabling the use of Amplifier AC111 as a high-quality tape record-playback amplifier, for use with high or low impedance heads. Incorporating pre-amplifier, oscillator supplying h.f. bias and erase sufficient for the highest coercivity tapes and recording level indicator. In kit form, with all valves, components, punched chassis circuits and full instructions. £4/4/-, plus 5/- carriage.

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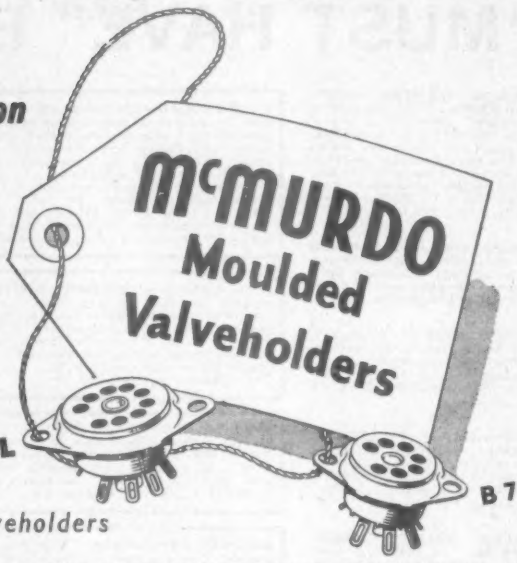

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6v BATTS, 85 amp-hr 70/-, 120-140 amp-hr £5 del.; remote control relays, 12v 800amp, ex-F.A.F., 16/-.
DOUGLAS twin air cooled petrol engine driving alternator, 110/1/50, 1.25 kva, automatic voltage control, voltmeter, main switch and fuses, £35 del.; also some d.c. sets, small, economical to run.—See August "W.W.," page 74, also battery chargers.
PLEASE do not ask for catalogues; see displayed advert, page 108 for S.T.C. selenium rectifiers; terms, c.w.o., pro-forma invoice, c.o.d. (post goods only).
PEARCE, 86, Great Percy St., W.C.1 (near Angel). [0014

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PLEASE write for details to K.T.S., Ltd., 60, Aylward Rd., London, S.W.20. (Liberty 4426.) Callers by appointment only. [6724

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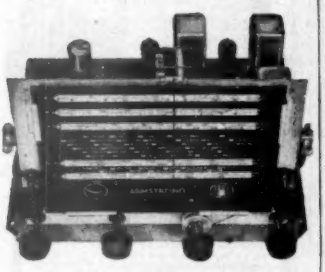

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TELEVISION! Set of 3 components, comprising line output trans., with E.H.T. winding to give 7 kV. using EY51 (heater winding for EY51 also included), and fitted with width control scanning coils, low impedance line and frame, focus coil (res. 10,000Ω), current approx. 20 mA); the set of 3 for 42/- plus 1/6 post, diagram of line trans. supplied, scanning coils, as "Viewmaster," low imp. line and frame, 12/6 plus 9d. MINIATURE iron cored coils, former size 1⅝"×⅝in adjustable core, set of 4 coils, M.W., AE and OSC, S.W., AE and OSC, 5/11, post 6d; mains dropping resistors for .15a valves, 980Ω, tapped at 650 and 700Ω, small size (3in×⅝in), 2/3.

A.C./D.C. amplifiers, complete kit for construction of 20w. 8v amplifier, by McMurdo, all first-class components by Partridge, Gardner, etc., valves 4×CL33, 2×EF37, 2×UR8C, black crackle, chassis and case, isolated from mains, and drilled, circuit diagram supplied, everything complete, £50/10/6, carr. paid; television focus coils, for 9 or 12in mag. tubes, res. 10,000Ω, average current 20mA, 7/6.

PERSONAL receivers, 3 valve T.R.F. using 1T4s, contained in handsome bakelite case with lift-up lid, size 7"×6½"×5in with lid closed, plastic carrying handle, fram AE in lid, these receivers cover the medium waveband and operate from self-contained dry batts., standard types, W1435 and D2, output to a pair of lightweight 'phones (H.R.) controls, SM tuning and reaction, opening lid switches on, supplied brand new, with valves, batteries, 'phones, an ideal set for invalids, hosp. patients, etc., these receivers are not clox surplus and are offered ready to play; carr. paid £4/4.

CHASSIS steel 5¾×5¾×1¾in drilled 3 button base holes 1/9, 5×9×1½, drilled 5 button base holes, 2/3, 11.17×1.25×3, drilled 7 int. octal and square, open ends 3/-, all. 14¼×10×2¾ drilled 10-B8A, 5 int. octal, ex. T.V. 4/3; primary 0-110-210-240v 50c/s, secs 300-0-300v 80ma, 4v 2a, 6.3v 2.5a, 5v 1.5/6, heater trans., auto. wound 200/250v 50c/s to 6.3v 3a, 8/-; smoothing chokes 20H, 80ma 350Ω 6/11, 5H, 200ma 100Ω 5/6, 8H 250ma 50Ω size 4×5×5 potted 10/6 post paid; electrolytics 32mf 350v card 2/-, 32-350v can 2/6, 25-50v w/e 1/3, 100-12 1/3, 16-450v can 2/6, 8+4 450v can small 2/9, 8+4 275v 2/-, 2-450v 1/6; switches standard Yaxley type, 2p 4w 1b with shorting wafer 2/-; superhet coils 1½×1¾, formers M. wave H.F. AE, Osc, L, wave H.F., AE, Osc, 1/9 per coil; I.F. trans. 465kc/s 1½×1½×4in iron cored 6/- pair; meters 2in square bakelite cased, 0/5ma 6/6 0/50ma 7/6 0/300 d.c. with series res. 7/6, bakelite cased 2½in circular 0/200ma 9/6; Rotary power units type 104, p.m. rotary mounted on chassis with supp. input 12v d.c. output, 250v 60ma, 6.3v 2.5a d.c. 7/-, type 87 24v input, outputs as 104 6/6 post paid; plugs and sockets, bakelite with keyway 5, 7, 1/6 pair; extension speaker controls 10Ω wire wound, ½in spindle 9d; "Pye Strips" the well-known 45ms/s vision strips, brand new, as type EP50s, with EP50, perfect condition, 39/6, plus 1/6 post; focus coils, low res., 200Ω, standard TV 8/6, can be had as alternative with kit, if required; 6½in loudspeakers, p.m. less trans., boxed, 12/6 post paid; Mansbridge conds., 4mf 1,000v wkg. 5/-; v.c. with sp switch long spindle 25k, 50k, 100k, 2m 4/-.

SMALL, size iron cored I.F.s. 465kc/s, size 1in×1⅛in×2½in. 8/6 pair; frame aerials for personal sets, etc., medium wave, rectangular winding, size 6½×4¼×¾in, wound round 4 wooden bobbins mounted at the corners of an ali. plate, tabs for connections 2/6 post paid; output trans., 5,000/3,750, 2/11; valveholders, Amphenol, B8A 7d. ea. octal 7d. ceramic int. octal 10d.

RADIO CLEARANCE, Ltd., 27, Tottenham Court Rd., London, W.1. Tel. Museum 9188. [0015

SUPREME RADIO, 746b, Romford Rd., Manor Park, London, E.12. Tel. Ill. 1260. Est. 17 years.

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0.001MFD 600v tub. cardboard condensers, 2/6 per doz; 0.1mfd 1 k/v tub. cardboard cond., 1/- ea or 11/- doz; 2mfd 350v tub. metal tag end cond., electrolytic, 1/- ea; 16+24mfd 350v tub. card., with fixing clip, 3/- ea; metal can. cond., 16mfd 350v, 1/9 ea; carbon vol. controls, 0.5 meg., small size with s/p switch and med. spindle, 3/6 ea; 100 k/ohms, with long spindle and s/p switch, 2/6 ea. 0.25meg., less switch, with long spindle, 2/- ea; 5meg., 2½d ea.

PERMANENT magnet focus units, for triode or tetrode tubes, also high flux type, 16/6 ea; drop thro' type mains trans, tapped primary, 0-250v on voltage panel, sec., 275-0-275v 80 m/a., 6.3v 3amp. 5v 2amp. with screen, 15/11 ea; L.T. heater trans, 0-200-230v, 6.3v 1.5amp, our price 6/9 ea; Westinghouse type metal rect., 250v, R.M.S., 65 m/a., moulded 317G valve holders, 10d ea; E.F.50 ceramic v/hids, 7d ea; slate type E.F.50 v/hids, 6d ea; int/octal Amphinol v/holders, 7d ea.

PF/S, 100pf, 70, 65, 50, 40, 30, 307, 530, 570, 1,800, all at 2/6 doz, or ass. trimmer panels with 2 50pf and 2 35pf trimmers, 9d ea; 2-pole 2-way small rotary switches, 8d ea; flat type mains dropper, tapped for 200-250v, 630 ohm, 0.2amp, 1/6 ea.

GLASS dials, 8¾in×4¾in, L.M.S. wave, station name for the new wavelengths, in 3 colours, 3/6 ea; metal escutcheon for same, 2/6 ea; pointer, 10½d; electrolytic cond, 16+16mfd 450v tub. cond, cardboard, clip mounting, 2/9 ea; 8mfd 350v wire end tub. cardboard, 2/6 ea; bias cond, 80mfd 50v, 50mfd 12v, 25mfd 25v, 1/3 ea.

TERMS, C.W.O., no C.O.D.; send 6d extra for postage orders under £5; 2½d s.a.e. all enquiries and list. [0021

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MOULDED MICA CONDENSERS. .0001, .0002, .0003, .0005, .001, .002, .005, all at 5/6 dozen.

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HIGH resistance headphones, with good type microphone, padded double headbands, sponge rubbers on earcaps, all wired into large 4-cleft plug as per R.A.F. adverts, as new, 8/9 per set.

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SMALL porcelain jumbo, 4-pin bases; 4/- each.
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TELE plugs, jacks, 6d; sw coils, 20k potms. 1. 6d; sw chokes, tub conds, 3d; LR chokes, 1/6 topcaps 1d, sleeving, A.E., 2d, 50/12 4d; Spdt, 6d, p'buttons 3d; 7193, 1/9, 2B6, 3/6; s.a.e. lists; lost extra.
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SPOTLESS surplus. Mains trns 300-0-300, 6v. 5v, 100ma, 17/6; int/oct hldrs (amph) 6/6 doz; co-ax cable 80 ohm 12/6 doz yds; V/controls, semi-midget, ½ meg and 50k, L/spindle, less/sw 2/6; standard ½, 1 and 2 meg, with/sw 4/3; fresh stock 16m f/450v. conds 4 for 12/-; other bargains; stamp list.—Radio Unlimited, Elm Rd., London, E.17. Tel. Key 4813. [0062
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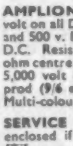

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SALARY will be assessed according to age, qualifications and experience within the range £330-£545 per annum.
APPLICATIONS, giving age and details of technical qualifications, apprenticeship (or equivalents), workshop and drawing office experience, should be sent to Admiralty (C.E. II, Room 88), Empire Hotel, Bath. Candidates required for interview will be advised within two weeks of receipt of application. [6952

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THEY should be between 25 and 35 years of age and preferably have a degree in electrical engineering (tele-comunications and electronics) or be corporate members of the Institution of Electrical Engineers or have equivalent qualification.
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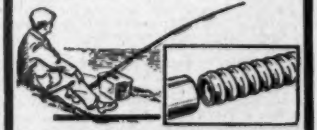

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EXPERIENCED engineers required to fill the following vacancies in the Electronics Laboratories of a company situated near London:—
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3. DESIGNER Draughtsmen to work on light mechanical devices associated with electronics generally. Applicants should hold a Higher National Certificate or equivalent, preferably in Mechanical Engineering.
THESE posts qualify for the Company's pension scheme. The work is both novel and interesting and involves the development of new techniques, but not original research. Successful applicants will, after a probationary period, be expected to carry the full design responsibility of a particular project.
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EXPERIENCED radio and television engineer required, permanent position, good wages.—Apply Maxwell & Sons, Ltd., 45, Hill Rd., Wimbledon. [7344

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(II) ENGINEERS and scientists for research and development work in the following fields: Radar, radio and electronic circuits, micro waves, high power centimetric valves, vacuum and/or high voltage techniques servo control and electro-mechanical devices. Qualifications include a good degree in physics or electrical engineering or mechanical engineering or equivalent qualifications. Previous experience is an advantage but is not essential. Salary according to qualifications and experience in the range £420–£1,000 per annum. Please quote reference R.T.E.
(III) TECHNICAL assistants for experimental work in the fields listed in (II) above. Qualifications required: A degree or Higher National Certificate in electrical or mechanical engineering or equivalent qualifications. Salary in the range of £260–£550, according to age and experience. Please quote reference R.T.A.
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SITUATIONS VACANT

RADAR and electronic technicians are required for repair and maintenance of radar and electronic control and computing equipment in the Glasgow and Edinburgh areas. APPLICANTS should have had experience comparable with the standard of Armament Artificer (R.E.M.E.) or hold National Certificate in Electrical Engineering or equivalent qualifications. SALARY in scale £437 (at 26) by £20 to £545. APPLICATIONS should be addressed to A.D.M.E., 3.A.A. Group, Riccarton House, Currie, Midlothian, giving details of experience, qualifications and age. [7414

STOCK and material control; man of ability and preferably with experience of radio and dry battery manufacture required; age 28–35; S.E. London area.—Write Box 3822. [7407

LEADING company requires man to take charge test personnel on T/V transmission and ancillary equipment; applicants please state age, experience and salary required.—Apply Box 3806. [7391

FERRANTI, Ltd., Moston Works, Manchester, have staff vacancies in connection with special electronic valve development and manufacture in association with an important radio tele-control project.

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WANTED experienced men for assembly work on Post Office type relays; good wages; also young men learners.—Apply, Alec Davis Supplies, Ltd., 18, Tottenham Court Rd., W.1. Mus. 2455. [7436

T/V radio engineer required, by established dealer; capable to act on own initiative; City and Guilds or equivalent qualifications, age between 24/48 years; driving necessary; North-west area.—Box 3801. [7372

INSPECTORS (electrical) required to work in Tolworth area, good pay, canteen facilities and excellent working conditions.—Apply, Personnel Officer, Decca Radar, Ltd., Shannon Corner, New Malden, Surrey. [7371

TELEVISION engineer required, first-class rates and excellent working conditions.—Write, stating age, qualifications, experience and salary required, to British Relay Wireless, Ltd., Services Department, 397, Albany Rd., S.E.5. [7352

ELECTRONIC engineer or physicist required by the Division of Atomic Energy (Production) to take charge of a group concerned with the maintenance and modification of electronic instruments at Windscale Works, Sellafield, Cumberland.

CANDIDATES must have either an honours degree in engineering or physics, corporate membership of the Institution of Electrical Engineers, or associateship of the Institute of Physics, or alternatively, have attained high professional standing in the electronics field. They must in any case have had wide experience in the repair and maintenance of electronic equipment, have a sound knowledge of electronic principles and pulse techniques and, preferably, have had experience in the management of a group concerned with electronic instrument maintenance.

SALARY will be assessed according to qualifications and experience within the range £720–£960 p.a. Voluntary contributory superannuation scheme. A house will be available within a reasonable period for the successful candidate, if married.—Application to Ministry of Supply, D.At.En.(P), Risley, nr. Warrington, Lancs, stating post applied for. [7359

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DRAUGHTSMEN experienced in light current, electro-mechanical, precision mechanical and electronic equipment are particularly needed.

CANDIDATES must be British subjects of 21 years of age and upwards who have had practical workshop experience (preferably an apprenticeship) together with drawing office experience.

APPOINTMENTS will be in an unestablished capacity, but opportunities may occur for qualified staff to compete for established posts.

THE salaries according on age, experience, ability and place of duty, will be within the range £320—£560 p.a.

HOSTEL accommodation is available at some establishments.

APPLICATIONS, stating age and details of technical qualifications, apprenticeship (or equivalents) workshop and drawing office experience, should be sent to Admiralty (C.E.II, Room 88), Empire Hotel, Bath, quoting DM/R.D. Original testimonials should not be forwarded with application. Candidates required for interview (at London or Bath whichever is nearer) will be advised within two weeks of receipt of application. [7367

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E. K. COLE, Ltd., have vacancies for testers at their Electronics Division; experience in the testing of radar, communications or electronics equipments to Min.stry specifications essential.—Full details in writing to the Personnel Manager, Malmesbury, Wilts. [7340

HARRODS, Knightsbridge, require a fully experienced television engineer; permanent position for man under 40; sick pay and pension scheme.—Apply in writing, or personally before noon any day except Saturday, to Staff Manager, 44, Hans Crescent, S.W.1. [7324

SENIOR designer draughtsman required with experience of design and development of radar and electronic apparatus to service requirements S.E. London area; applicants to state age and salary required and details of experience and qualifications to Box 2617. [7152

RADIO engineer required by North London manufacturers' service department; sound education and adequate technical training essential; applicants should give fullest information of general and technical education, experience, age and salary required to Box 3635. [7347

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3. DESIGNER draughtsman, H.N.C. desirable, should be capable of working on own initiative and doing all necessary calculations, and draughtsmen with general electronic and/or mechanical experience; salary according to qualification and experience. (Ref. AEF.)
APPLICANTS should write, quoting appropriate reference to Box 3306. [7306

WORKSHOP and office juniors are required by radio company in North London district, opportunity for lads with interest in radio to progress in service or technical correspondence sections, after a period of general duties.—Apply giving full details of education and age to Box 3636. [7348

CIRCUIT engineer with experience of radar pulse techniques required for work on digital electronic computing machines.—Apply, giving particulars of age, qualifications and experience, to the Secretary, British Rayon Research Association, Barton Dock Rd., Urmston, Nr. Manchester. [7328

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APPLICANTS for junior posts should have a good industrial experience, be qualified either by City & Guilds Certificate or by Inter B.Sc.
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A NUMBER of senior and junior vacancies for radio, radar, electronic, television, etc., development, service engineers, draughtsmen, wiremen, testers inspectors, etc.; urgently required 30 television service engineers.—Write in confidence, Technical Employment Agency, 179, Clapham Rd., S.W.9. (Brixton 3487.) [0105

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JUNIOR draughtsman required for interesting detail work on electro-mechanical apparatus in connection with radar and electronics. S.E. London area; applicants to state age and salary required and details of experience and qualifications to Box 2618. [7155

ENGLISH ELECTRIC Co., Ltd., have vacancies for senior and junior electro-mechanical engineers for interesting work on long term project; location Bedfordshire; a degree or equivalent in electrical engineering or physics essential; experience in one or more of the following fields desirable:—(i) SERVO-MECHANISMS; (ii) Instrumentation; (iii) Electro-mechanical design; (iv) Vibrations; (v) Electronics; (vi) Electro-mechanical or electronic computing. SALARY scale—senior engineers up to £1,200 junior engineers up to £600. APPLICANTS should write giving full details and quoting ref. 254A to Central Personnel Services, English Electric Co., Ltd., 24/30, Gillingham St., Westminster, S.W.1. [7405

McMICHAEL RADIO, Ltd., require qualified draughtsman with experience in the mechanical design of radio and electronic instruments for the Government services; salary will be commensurate with ability.—Write, stating age, training, experience and salary required, to the Chief Engineer, Equipment Division, McMichael Radio, Ltd., Slough, Bucks. [7103

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MURPHY RADIO, Ltd., have vacancies for senior mechanical designers in their electronics division; a full and varied programme ensures opportunity of widening experience with excellent prospects; application giving particulars of training and experience should be made immediately to—Personnel Dept., Murphy Radio, Ltd., Welwyn Garden City. [7408

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RADIO testers and fault finders required for work of national importance; men with experience of domestic radio, television or V.H.F. communications, can be offered attractive posts according to their ability.—Applicants, who must be prepared to reside in the Midland area, should write giving full details of experience and present salary, to the Personnel Officer, Ref. (Radio Test), Box 3233. [7270

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APPLY Employment Manager, Vickers-Armstrongs, Ltd. (Aircraft Section), Weybridge. [7389

BRITISH OVERSEAS AIRWAYS CORPORATION have vacancies for radio mechanics experienced in radio maintenance and/or overhaul; rates of pay 2/10 per hour plus 4½d per hour provisional bonus; attracting proficiency pay up to 3d per hour; 5-day, 44-hour week; possible shift work; good pension, sick pay and holiday facilities.—Write or call, Staff Manager, Hut 29, London Airport. [7315

THE ENGLISH ELECTRIC Co., Ltd., offers unusual opportunities for young engineers in the design and application of electrical instruments and protective relays with the assurance of stability of employment and exceptionally good working conditions.—Applicants should write, giving full particulars and quoting Ref. 406E, to Central Personnel Services, English Electric Co., Ltd., 24-30 Gillingham St., London, S.W.1. [7353

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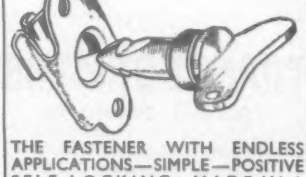

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E. K. COLE (Electronics Division) offers excellent opportunities for young draughtsman of Ordinary National standard to gain experience in the development of radar, communications and nucleonic equipments. Also a limited number of vacancies for senior draughtsmen with experience of this type of work.—Apply, giving details of experience, to Personnel Manager, E. K. Cole, Ltd., Malmesbury, Wilts. [7094

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YOUNG engineer required for component development and design; good scope for advancement in this field and opportunity for progress to other branches of communications' work; qualifications required: Engineering or physics degree or Inter B.Sc., with some experience of A.C. work or equivalent.—Apply in writing stating experience in full, salary required, etc., to Personnel Department, Ref. V/T, Pye, Ltd., St. Andrew's Rd., Cambridge. [7351

TECHNICAL assistant, aged 20-30, required in L. works laboratory for work on development of recording materials for lacquer discs, recording wax and magnetic tapes and discs, previous experience desirable but not essential provided applicant is keenly interested in this class of work, which is varied and interesting and offers good prospects of advancement, matriculation or equivalent.—Apply to Personnel Department, E.M.I. Factories, Ltd., Hayes, Middlesex. [7383

BELLING & LEE, Ltd., Cambridge Arterial Road, Enfield, Middlesex, require research assistants in connection with work on electronic components, fuses, interference suppressors and television aerials; applicants must be graduates of the I.E.E. or possess equivalent qualifications together with similar laboratory experience; salary will be commensurate with previous experience; applications must be detailed and concise, and will be treated as confidential. [6997

REQUIRED immediately by large firm in London area, senior and junior radio development engineers to work on long-term projects of high priority; applicants should have experience in the development and design of V.H.F. communication equipment; for the junior posts, however, experience is not essential provided applicants have adequate grounding in basic electronics technique; posts permanent and pensionable.—Apply quoting reference R. E. D. to Box 3629. [7333

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ELECTRONIC engineers required for interesting development work in a steadily expanding company in the West London area, specialising in light electrical products, candidates must have degree or equivalent qualifications and some years laboratory experience on design of radar or similar equipment; starting salary in range £750 -£1,000, according to experience, with excellent prospects for men of ability and initiative.—Applicants should write giving full details of qualifications and experience to Box 3802. [7362

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ELECTRONIC engineers required by Government Department, candidates should have knowledge of general electronic or pulse technique or telecommunications up to H.N.C. (or equivalent standard), with subsequent electronics experience; duties: maintenance and fault tracing and development work; location: Cheltenham, Glos; salary: within the scale of £240-£570 per annum (provincial rate).—Write for application form to Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting reference D263/51—A. Closing date 12 October, 1951. [7379

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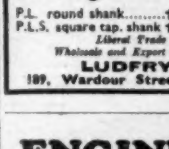
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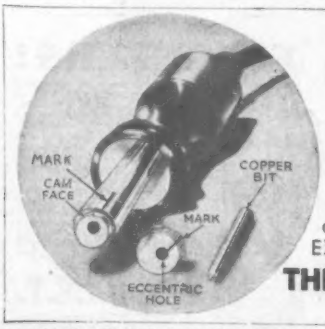

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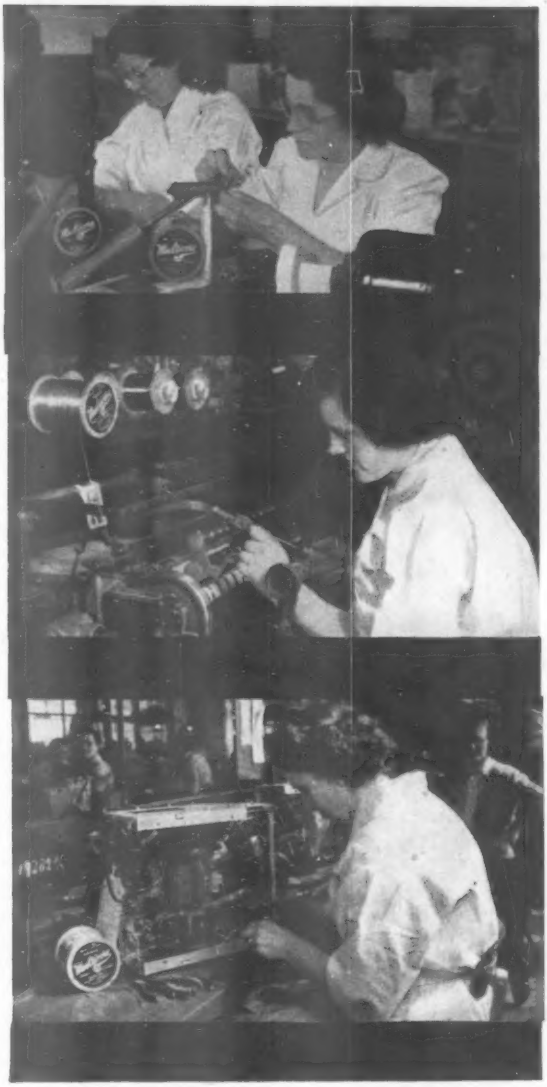

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